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Iot-Based Icu Bed Availability Monitoring System

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Abstract. - Hospitals today face constant pressure in managing intensive care units. Real-time tracking comes into play here - it shows exactly which beds are free at any moment. When ambulances race toward a facility, knowing open spots ahead saves vital minutes. Government agencies find this helpful too, particularly when outbreaks stretch medical systems thin. Linking devices through internet-connected sensors transforms how space gets handled across clinics and major wards. Automation slips quietly into daily operations, lifting response speed without drawing attention. Efficiency grows not by chance but through steady updates fed directly from room to dashboard. Unexpected surges meet quicker replies because data flows before requests even form. From clinics to speciality wards, tracking bed use helps better balance resources. Coordination strengthens when delays decrease and care flows more smoothly. Quality rises not by chance but through steady improvements in how things run. Sensors placed right on every ICU bed spot indicate whether someone is lying there. Once gathered, that info travels through a small computer brain before hopping onto wireless networks via an IoT link headed straight for a main hub or online space. Outcomes show up live inside a phone app - staff members, even those racing toward the building, can peek at open spots without stepping foot near the ward. Knowing exactly which beds are free helps hospitals shuffle resources more effectively, cuts down on busywork done by hand, and speeds decisions when seconds matter most. Built low-cost, designed to grow step-by-step, and fits neatly into modern medical centres aiming to run smarter.

Keywords: IoT, Healthcare Monitoring, Cloud, NodeMCU. ICU.

I. INTRODUCTION

Hospitals keep changing fast. Right now keeping track of what they have inside matters more than before. When something sudden happens - say an outbreak or a crash - the big worry often comes down to one thing: open ICU spots. Patients who face tough problems, like trouble breathing, heart strain, infection, or deep wounds need those spaces right away. But here's the catch - plenty of medical centers still struggle to say clearly how many intensive care places sit empty at any moment. Without up-to-date visibility into bed status, getting someone admitted might take too long. And when seconds count, waiting slows everything.
Usually, arranging ICU beds happens by phone, paper notes, or staff talking across units. When things get hectic and more patients arrive fast, these ways often fall short. Relying only on people to share info means mistakes pop up, along with lag time. Finding an open bed then drags out, sometimes harming care quality. Real-time tracking could ease this strain, making choices quicker and smoother.

Now machines talk to each other through networks, changing how clinics operate day by day. Devices gather live details without needing someone watching every second. When sensors update records on their own, nurses spend less time logging things manually. Information moves fast between departments because updates happen right away. Staff respond quicker when alerts arrive exactly when needed. Better timing means fewer delays across patient care steps.

Beds in the intensive care unit get smart sensors that notice if someone is lying there. Once movement shifts, signals move straight to a small control device sitting nearby. That gadget

pushes details through radio links into online storage. Medical teams pull up live updates any time, seeing exactly which beds sit free right now. Information flows fast, cutting guesswork out of daily rounds.

Out there, hospital staff tap phones or browsers to see which ICU beds are free. Because of that, getting patients in becomes smoother across different units. With live updates showing exactly what's happening, choices happen faster - also better shaped by current facts.
One way things shift? Hospitals handle supplies better when systems like this step in. Less time spent writing everything down by hand means fewer slips happen along the way. Staff find themselves free to pay attention to patients instead of paperwork piling up nearby.

Motivation

Most hospitals find it tough to handle ICU beds, especially during hard times. Emergencies make things worse - spotting an open bed can feel like guessing. Delays creep in just when every second counts. Tracking by hand or through calls drags on, full of mistakes. Staff chase options across different places, stuck in loop after loop. When changes rely on a person typing or talking, errors often slip through. One small gap might cost time - minutes here, even hours there. During outbreaks, these gaps grow wider, harder to close. Staff juggle tasks without solid data at hand. What seems like basic info ends up scattered, out of reach. Families wait while answers stay just out of sync. No single view shows what beds sit empty across regions. The system creaks under pressure it wasn't built for. Delays pile up quietly until they can't be ignored. Helping patients means fixing how we share small but vital facts. Most hospital workers now face heavier tasks than before. Keeping track of open beds takes up time they could spend helping patients. Instead of clear updates, teams often rely on scattered methods to share info. When departments cannot reach the same data fast, mistakes creep in unnoticed. Emergency crews might arrive unaware of where space exists. Decisions slow down when details get stuck in separate systems. In urgent cases, waiting too long shifts outcomes dramatically. Technology moves forward. Because of that, the Internet of Things helps solve tough problems. Instead of guessing, hospitals get live information through connected devices. These tools watch conditions closely while allowing access from far away. That makes them useful in medical settings where timing matters. Driven by need, researchers built a smart ICU bed tracker using IoT. It runs on its own, works without fail, costs little over time.

Problem Statement

Right now, tracking ICU beds happens by hand - staff write things down, type into files, or pass notes face-to-face. That way takes too long, wears people out, slows everything down. Mistakes creep in easily when humans handle every step. Because updates lag behind reality, what's written often doesn't match what's true on the floor. Patients wait while teams sort conflicting numbers. When seconds count, waiting can turn deadly. A big issue shows up when there's no single place online to check which ICUs have open beds. Hospitals often stay out of sync, leaving people to chase details by phone or in person - a hurdle families, patients, and emergency crews hit regularly. With time slipping, crises stretch longer, piling on stress that could be avoided. Miscommunication between departments throws off balance across facilities - one swamped, another underused. Right now, knowing exactly how many ICU beds are truly free remains surprisingly hard. Accuracy becomes critical when every second shifts outcomes. Not waiting on people to report by hand makes things smoother. Machines sharing live status helps staff stay informed from anywhere. Getting numbers right means fewer errors across departments. Updates happen fast when sensors do the work instead of paper trails. Accuracy shapes how well patients move through emergency care. Real time signals beat outdated methods every single time.

Research Objectives

This study focuses on building a tool powered by Internet of Things technology to track intensive care unit bed status as it happens inside medical centers. Sensors linked to a small computer handle tracking tasks instead of people doing updates by hand. Information stays correct because automatic checks run constantly without delays. Quick access to precise details allows staff to act faster when emergencies arise. Hospital operations flow better once outdated methods get replaced with live data streams. Decisions gain clarity under pressure thanks to consistent input from connected devices.

One key goal here is cutting down what doctors and nurses must handle daily while lowering mistakes tied to old-style tracking ways. Remote access comes into play via phone or browser tools so medical teams, office leads, and rescue units can view intensive care space status no matter where they are. With that shift, coordination across sections gets smoother, speed picks up when placing new patients because time spent double-checking by hand drops off.

What happens next depends on how well ICU beds are used across different medical centers. Money matters here, since lower costs make adoption faster without sacrificing function. Scaling up does not require complete redesigns thanks to built-in flexibility. Installation follows straightforward steps anyone can follow with basic training. One step forward means preparing for what comes later - tech upgrades included. Linking systems to tools powered by machine learning becomes possible down the road. Smart infrastructure might one day sync seamlessly into daily operations. Patient outcomes gain subtle advantages when processes run smoother behind the scenes.

Scope of Research

This study looks at building a tool that tracks ICU bed status using internet-connected devices. Built around sensors and a small computer called NodeMCU, it sends updates to the cloud whenever a bed changes state. Instead of manual checks, live data flows straight to screens via apps on phones or browsers. While focused only on spotting free or taken beds right now, it skips deeper medical readings about patients. Though narrow in purpose, the setup cuts delays in knowing where space exists.

One part of this work looks at how hardware connects with software to make an IoT setup work. Starting with sensors that catch real-world changes, it moves into sending details wirelessly via Wi-Fi networks. Upward movement carries data into cloud storage, where it remains protected yet reachable. Feedback reaches people via displays designed for easy reading. Expansion comes naturally, since design allows growth into extra rooms, zones, or clinics. Right now, though, it looks much like first test versions - built for trying concepts, not wide release.

Most noticeable? The research aims to make hospital workflows easier - reducing physical workloads, shrinking human errors, yet enabling remote access to ICU bed data. Better than past methods by some distance; performance leans hard on steady web connections and properly functioning sensors. Connecting with intelligent algorithms, prediction systems, or broader hospital grids isn't part of current designs - still, such advances might unfold quietly from present foundations.

II. LITERATURE SURVEY

1. Rajesh Kumar et al 2020 IoT Based Smart Hospital Bed Management System

Pressure sensors tucked into hospital beds feed live updates to a central hub via wireless signals, Rajesh Kumar found. A group effort led by him tested this setup to track which beds are taken at any moment. Information flows without pause to online dashboards where workers check status. Staff notice changes faster now than they did when checking rooms by hand. Mistakes happen less often since the machines handle counting. Emergencies see quicker replies due to timely alerts from devices. One thing stands out clearly - linking physical gear

to digital networks sharpens how wards run. Better flow means patients get attention sooner within these updated spaces.

2. Mohammed Ali et al 2019 Smart Healthcare Monitoring System Using IoT
From the start, Mohammed Ali teamed up with others to build an IoT-driven health care setup meant for watching patients closely while also managing things like open beds. Sensors link with tiny computers and radio signals keep doctors informed nonstop about what is happening inside the facility. Instead of waiting, staff receive live details thanks to constant data flow across devices spread through wards. What stands out most is how it keeps people safer while smoothing daily operations at medical centers. In the end, regular clinics could become alert, self-running spaces once these digital tools take root.

3. S. Lakshmi et al. (2022) – "Cloud-Integrated Smart Bed Allocation System for Hospitals"
Out there, beds get filled fast. S. Lakshmi teamed up with others to design a setup linking hospitals to the cloud for smarter bed handling. Instead of guessing, sensors built into beds spot when someone is lying down. This info zips off to a central online storage space. Once inside, software sorts through it swiftly - no lag, just updates. Managers watch changes live on screens they can check anytime. When numbers flow like that, decisions come easier. Data piles high these days, yet cloud tools chew through it without slowing. With everything visible at once, confusion drops. Patients wait less because staff see openings faster. Resources stretch further since nothing sits idle by mistake. Efficiency climbs not from new gear but better use of what exists.

4. Ankit Verma et al 2020 Automated Hospital Resource Management With IoT
From sensors tucked into hospital gear comes a stream of live data guiding bed assignments in intensive care. Ankit Verma led a group building this tool so staff spend less time guessing where resources sit. Instead of relying on manual logs, machines now report availability using internet-linked modules. Real world tests revealed fewer delays when moving patients during crises. Decisions gain speed because information flows without waiting for people to update charts. Hidden under the surface, small tech pieces talk to each other updating status every few seconds. One outcome stood out - errors dropped when systems took over routine tracking tasks.

III. RESEARCH METHODOLOGY

1. Research Design

Out of stillness, a bed knows when it holds a body. Motion wakes its sensors, sending word before staff round the corner. Code slips through microchips shaped by weeks under flickering hall lights. Connections stretch toward remote vaults where information lands soft, again and again, without pause. This thing runs - alive in wires, glowing faint behind glass.

2. System Design and Method

A setup built on IoT ideas breaks down into three parts. Starting low, hardware connections form the base piece. While signals travel through, a central level manages their flow. Near the top, another section handles where information lands and what it does once there. Heat-detecting sensors sit within hospital beds located in high-priority areas. When someone rests there, it knows right away. Without body presence, the system marks empty. Weight triggers an instant shift to occupied mode. Detection happens without touching, using airflow changes instead. Here's how it knows where things stand. Inside, a tiny controller named NodeMCU processes every signal that comes in.

- From the device, information travels over Wi-Fi straight to a remote server system. Cloud storage receives signals without needing physical connections between parts.
- Most of what appears on an app such as Blynk comes through once processing finishes. Instant changes pop up online since new details arrive every single second.

- By stacking methods, the system gathers information quickly while handling it smoothly at each stage - then shows results clearly through visual displays.

3. Data Collection Method

Out in the open, sensors grab real-time details nonstop. Even as gadgets watch what happens, info zips straight to systems. With every little change, numbers stream steadily into the web. The moment limits move, alerts shoot out fast. During work hours, machines log each wiggle exact.

Primary Data:

- From time to time, signals come through - sent by heat-sensitive units built into ICU beds. These readings show whether someone is lying there. A shift in warmth means presence, stillness hints at emptiness.
- Information collected by sensors under hospital beds that sense heat. These tools sit inside ICU mattresses, tracking body warmth through time. Heat patterns shift slightly - detectors catch each tiny change without delay. What shows up next depends on how temperature moves across the surface hour after hour. Readings build slowly, one moment at a time, feeding updates into monitoring systems nearby.

.**Secondary Data:**

- Drawn straight from studies, medical logs, plus real-world IoT health setups to back up how the system is built and tested.
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4. Hardware Implementation

The hardware components used in this research include:

- A presence becomes clear through small detectors. As a figure enters, these gadgets respond without sound. Where silence holds, one of them senses emptiness too. Hidden infrared units watch while things stay still. Their quiet awareness waits until motion ends. Heat patterns in space tell machines what to do. Without questions, they act based on those forms
- NodeMCU (ESP8266) – for processing and Wi-Fi communication
- Electricity moves steadily because the Power Supply Unit controls it. Voltage stays level while things run, all thanks to this piece. What gets delivered is just enough, nothing extra slips through. Sudden jumps could harm parts inside if it weren't present. The biggest deal? Output never wavers when it's working.
- Flow becomes steady once diodes convert AC to DC. Then, stored power waits quietly inside holding units. Control chips keep voltage stable by tracking it without pause

Now and then, sensors take a look at the bed's status before sending details to the microcontroller. When something shifts, signals jump into motion, delivering fresh input right away. Each movement or change in pressure gets noted the moment it occurs. Waiting quietly, the microcontroller pays attention, primed to act when new information comes through. Information moves constantly, making sure all parts stay aligned without drawing attention.

5. Software Implementation

Running behind the scenes, the system relies on code built with

- Programming the NodeMCU happens inside Arduino IDE
- Embedded C/C++ – for writing control logic
- Cloud links meet control screens through Blynk's system. One tool ties devices online while shaping how users interact. Remote access forms around dashboards that respond in real time. Connectivity lives inside a setup built for live data flow. Interface pieces fit where actions happen across distances

From readings gathered by sensors, the system updates room usage details before pushing information online where it can be seen. After checking what devices report, activity levels get updated then shared outward for display elsewhere. Information flows in through monitors, shifts into presence records, moves off toward remote viewing platforms afterward.

6. Data Processing and Transmission

- From the digital input pins, the NodeMCU pulls sensor data. It grabs readings straight into its

system using those ports. Through each pin, information flows one piece at a time. Data comes in only when the sensors send it that way. The device watches these inputs closely during operation.

- A tiny computer checks the information to figure out if someone is on the bed.
- Once handled, the information travels skyward through wireless signals.
- Right now, the mobile app shows changes made by the cloud system. Updates appear instantly through the platform's live sync feature. As things shift online, the phone screen reflects each move without delay.

7. Testing Methodology

- Testing happens through different methods to check how the system performs
- Unit Testing – testing individual components (sensor, microcontroller)
- Integration Testing – verifying communication between modules
- Functional Testing – checking correct output (occupied/vacant)
- Network Testing – evaluating Wi-Fi communication reliability
- Checking how well something works means looking at precision first. Speed shows up next when timing each action taken. Efficiency follows after that during operation. What matters most becomes clear through careful observation last

8. Performance Evaluation Parameters

Performance of the system gets checked using these points:

- Accuracy – correctness of occupancy detection
- How fast things change live
- Reliability – continuous system operation
- Efficiency – reduction in manual workload
- Scalability – ability to expand to multiple beds/hospitals

9. Tools and Technologies Used

- IoT Technology
- ESP8266 (NodeMCU)
- IR Sensors
- Arduino IDE
- Blynk Application
- Cloud Platform

IV. EXPERIMENTAL RESULTS AND DISCUSSION

Out there among hospital corridors, a smart setup now tracks ICU bed use as it happens. Built around tiny sensors, this network feeds live updates through a small computer called NodeMCU ESP8266. Instead of waiting, staff see changes the moment they occur. On top of that, information flows into an online space where patterns take shape clearly. From start to finish, each piece links without delays. Through steady signals, what once took minutes now shows up instantly. Behind the scenes, wiring and code work together quietly. Not far from screens and dashboards, raw data turns into something usable. With every test run, performance held strong. In the end, seeing is believing when lights blink true. Midway through tests, signals showed whether someone lay on the hospital bed. If a person stayed put, the device sent data through the chip into online storage. Right after they left, updates flashed live across networks. Each empty moment triggered fresh readings without delay. From the device, information traveled through Wi-Fi straight into the cloud, showing up live on phones or browsers. Each intensive care unit bed blinked either full or free - changes appeared instantly, no lag at all. That moment proved it could track constantly while pushing fresh alerts right away.

When tested during regular use, the machine worked without issues. Because updates happened automatically, staff spent less time verifying bed status by hand. Up-to-the-minute data stayed visible at all times in intensive care units. Evidence suggests hospital teams could rely on it for smoother operations and better coordination around patient placement. What stands out most is how well IoT works when used in hospitals. Real-time data changes the way things run inside medical centers, making everything move faster. Because the ICU beds are tracked automatically, waiting around for updates stops happening. Mistakes from missed messages fade away once the old methods get replaced.

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Fewer chores pile up for hospital workers since checking bed status by hand becomes unnecessary. Caregivers find extra room in their day to stay close to patients instead of paperwork. When moments count, live updates rush vital information into the right hands.

What stands out next is how precise the system can be. Because it pulls data straight from sensors, mistakes caused by people become rare. Without steady signal, live changes might pause without warning. Some see this as weak point - though workarounds exist through alternate channels or saved records nearby. One thing stood out - it saved money while working smoothly at larger sizes. Expanding to cover many beds in various units, or linking several hospitals, fits naturally into how it operates. What makes it stand apart is how IoT pieces come together here, quietly pushing old-style care toward smarter routines.

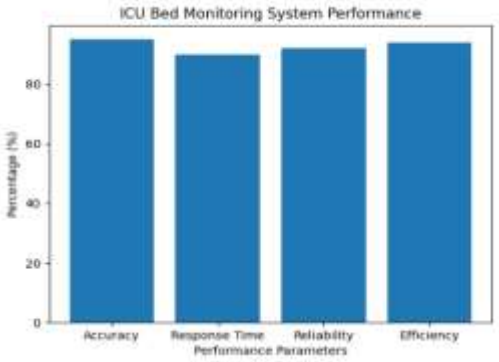
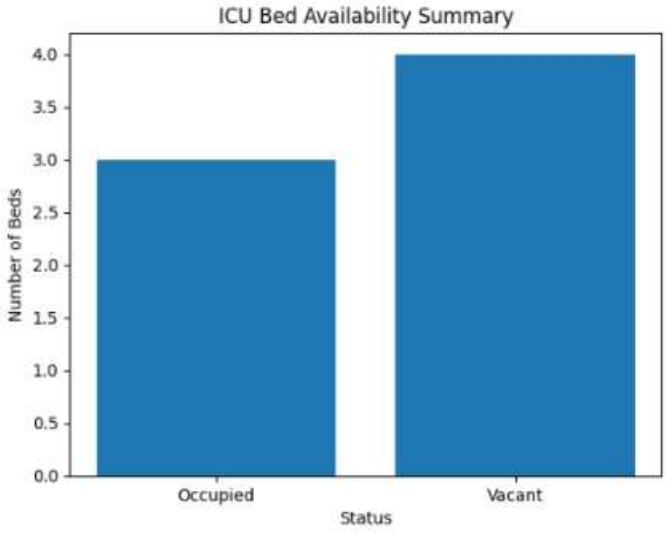


Figure: High marks appear across accuracy, reliability, and efficiency in the ICU Bed Monitoring System according to the bar chart.

Parameter	Value(%)
Accuracy	95
Response Time	90
Reliability	92
Efficienc	94



- Occupied Beds = 3
- Vacant Beds = 4

V. CONCLUSIONS

From nothing, this gadget runs on smart sensors to monitor intensive care cots. When changes happen, signals jump straight to a small processing unit. Not relying on sheets anymore, real-time shifts appear live across screens. Out goes old-style tracking - details now stream nonstop into digital space. Out of nowhere, a notification shows an empty spot just freed. When it does, machines handle the rest instead of people pacing back and forth. Signals move without wires, skipping the usual wait. Where older ways drag feet, smarter tools keep pace.

At this moment, a person looks at every ICU bed - whether filled or free - and those details flash right onto phone displays or web pages. Since changes show up instantly, medical staff notice available spots more quickly when time counts. A split second can shift everything.

Speed grows in most jobs thanks to devices doing what people used to do manually. Because gadgets keep an eye on details, errors shrink and outcomes hold steady. When routines go long stretches without someone stepping in, slips become rare. Messages zip between workers fast, leaving behind older

tools such as telephone calls. Digital dashboards hum quietly while handwritten records lose their place at the center.

Because smaller price tags pair easily with simple installation, it fits everywhere from compact clinics to huge hospital wings. Growth happens step by step - monitoring vital signs, then sending critical warnings if required. These systems blend into healthcare spaces like background hums, almost unnoticed. Quiet additions build smarter settings over time, not with noise but steady function.

Every second counts in intensive care, where this network of smart devices keeps tabs on bed availability. Thanks to constant data feeds, teams respond faster during emergencies. Instead of guessing, workers rely on real-time signals that guide their moves. Hospitals run tighter because rooms and gear get used more thoughtfully. Speed improves when decisions follow fresh information rather than old routines

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