

COLD CHAIN LOGISTICS MONITORING SYSTEM BASED ON NB-IoT POSITIONING



TUGAS AKHIR

**Disusun Untuk Memenuhi Syarat Menyelesaikan Pendidikan
Sarjana Terapan Pada Jurusan Teknik Elektro
Program Studi Teknik Telekomunikasi
Politeknik Negeri Sriwijaya**

Oleh:

Fildzah Shabrina Alfanshah

062240352306

POLITEKNIK NEGERI SRIWIJAYA

PALEMBANG

2026

TUGAS AKHIR
COLD CHAIN LOGISTICS MONITORING SYSTEM BASED ON NB-IoT
POSITIONING



Disusun Untuk Memenuhi Syarat Menyelesaikan Pendidikan
Sarjana Terapan Pada Jurusan Teknik Elektro
Program Studi Teknik Telekomunikasi
Politeknik Negeri Sriwijaya

OLEH:

Nama : Fildzah Shabrina Alfanshah
Dosen Pembimbing I : Ir. Lindawati, S.T., M.T.I.
Dosen Pembimbing II : Mohammad Fadhli, S.Pd., M.T.

POLITEKNIK NEGERI SRIWIJAYA
PALEMBANG

2026

LEMBAR PENGESAHAN
COLD CHAIN LOGISTICS MONITORING SYSTEM BASED ON NB-IoT
POSTIONING



TUGAS AKHIR

Disusun Untuk Memenuhi Syarat Menyelesaikan Pendidikan
Sarjana Terapan Pada Jurusan Teknik Elektro
Program Studi Teknik Telekomunikasi

Politeknik Negeri Sriwijaya

OLEH:

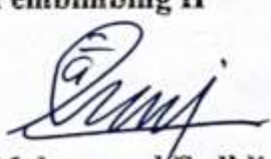
Fildzah Shabrina Alfanshah
06224035230

Menyetujui

Palembang, Agustus 2026
Pembimbing II

Pembimbing I


Ir. Lindawati, S.T., M.T.I.
NIP. 197105282006042001


Mohammad Fadhli, S.Pd., M.T.
NIP. 199004032018031001

Mengetahui

Ketua Jurusan Teknik Elektro

Koordinator Program Studi
Sarjana Terapan Teknik
Telekomunikasi



Dr. Ir. Selamat Muslimin, S.T., M.Kom., IPM
NIP. 197907222008011007


Mohammad Fadhli, S.Pd., M.T.
NIP. 199004032018031001

SURAT PERNYATAAN

Saya yang bertanda tangan dibawah ini menyatakan:

Nama : Fildzah Shabrina Alfanshah
Jenis Kelamin : Perempuan
Tempat, Tanggal Lahir : Pekanbaru, 23 Mei 2004
Alamat : Jl. Abdul Muis No.33
NPM : 062240352306
Program Studi : Sarjana Terapan Teknik Telekomunikasi
Jurusan : Teknik Elektro
Judul Tugas Akhir : Cold Chain Logistics Monitoring System Based on NB-IoT Positioning

Menyatakan dengan sesungguhnya bahwa :

1. Tugas Akhir ini adalah hasil karya saya sendiri serta bebas dari tindakan plagiasi dan semua sumber baik yang dikutip maupun dirujuk telah saya nyatakan dengan benar.
2. Dapat menyelesaikan segala urusan terkait pengumpulan revisi Tugas Akhir yang sudah disetujui oleh dewan penguji paling lama 1 bulan setelah ujian Tugas Akhir.
3. Dapat menyelesaikan segala urusan peminjaman/penggantian alat/bukudanlainnya paling lama 1 bulan setelah ujian Tugas Akhir.

Apabila dikemudian hari diketahui ada pernyataan yang terbukti tidak benar dan tidak dapat dipenuhi, maka saya siap bertanggung jawab dan menerima sanksi tidak diikutsertakan dalam prosesi wisuda serta dimasukkan dalam daftar hitam oleh jurusan Teknik Elektro sehingga berdampak tertundanya pengambilan Ijazah & Transkrip (ASLI & COPY). Demikian surat pernyataan ini dibuat dengan sebenarnya dan dalam keadaan sadar tanpa paksaan.



Palembang, Agustus 2026
Yang Menyatakan,



Fildzah Shabrina Alfanshah



山东科技大学
SHANDONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

本科毕业设计（论文）

Cold Chain Logistics Monitoring System Based on NB-IoT Positioning

学 院: College of Electrical and Information
Engineering

专业班级: Telecommunication Engineering

姓 名: Fildzah Shabrina Alfanshah

学 号: 202211111191

指导教师: Zhonghui Zhao

完成日期: 2026 年 6 月 15 日

学位论文原创性声明

本人呈交给山东科技大学的学位论文，除所列参考文献和世所公认的文献外，全部是本人攻读学位期间在导师指导下的研究成果。除文中已经标明引用的内容外，本论文不包含任何其他个人或集体已经发表或撰写过的研究成果。对本文的研究做出贡献的个人和集体，均已在文中以明确方式标明。本人完全意识到本声明的法律结果由本人承担。

若有不实之处，本人愿意承担相关法律责任。

本人签名：FILDZAH SHABRINA ALFANSHAH 日期：2026 年 6 月 15 日

学位论文使用授权声明

本人完全了解山东科技大学有关保留、使用学位论文的规定，同意本人所撰写的学位论文的使用授权按照学校的管理规定处理。

作为申请学位的条件之一，学校有权保留学位论文并向国家有关部门或其指定机构送交论文的电子版和纸质版；有权将学位论文的全部或部分内容编入有关数据库发表，并可以以电子、网络及其他数字媒体形式公开出版；允许学校档案馆和图书馆保留学位论文的纸质版和电子版，可以使用影印、缩印或扫描等复制手段保存和汇编学位论文；为教学和科研目的，学校档案馆和图书馆可以将公开的学位论文作为资料在档案馆、图书馆等场所或在校园网上供校内师生阅读、浏览。

（保密的学位论文在解密后适用本授权）

作者签名：FILDZAH SHABRINA ALFANSHAH

导师签名：赵中惠

日期：2026 年 6 月 15 日

日期：2026 年 6 月 15 日

ABSTRACT

The integrity of cold chain logistics is critical to the security and reliability of transporting temperature sensitive products such as vaccine, medicines, and perishable food items. One of the biggest sources of product quality deterioration and financial losses in the global supply chain is the unmonitored temperature fluctuation during delivery. The aim of this paper is to design and test a complete prototype of cold chain monitoring system based on Narrowband Internet of Things (NB-IoT) technology. The system is the only one that combines high precision location tracking and real time environmental sensing with ultra-low power consumption and, thus, solves the main disadvantages of conventional monitoring techniques such as high energy consumption and weak signal penetration.

A high-sensitivity temperature and humidity sensor is used by the created system design to obtain complicated data, with an STM32 microcontroller acting as the main processing unit controlling these operations. The system uses a GPS antenna combined with an NB-IoT module (BC20) for good visibility of assets. An important technical difficulty handled in this study is the naturally high-power usage of conventional GPS devices. To reduce this, the research uses a power-saving transmission scheduled by synchronizing data transfer intervals throughout the NB-IoT network using the MQTT protocol. The strategy exploits the better signal penetration of NB-IoT to allow the system to operate successfully even in distant locations or inside sealed shipping containers.

Session were tested using physical prototype to evaluate performance. The technique involved systematic firmware development with embedded programming, precise PCB design for hardware integration and complete integration testing with UART communication. The first results of the development phase show effective and steady data collecting and transmission through NB-IoT network, which was thoroughly tested by using SSCOM serial connection program. Command settings and apply systematic data formatting to reduce transmission errors. Thereby ensuring operational stability, and to address the usual communication delays and signal limitations. The final result show that the prototype is a very reliable, scalable and cost-effective way for monitoring things in real time. This method reduces

product loss in shipping and maximizes energy utilization, allowing for extended independent, portable operation in practical use.

KEY WORDS: Cold Chain Logistics, NB-IoT, STM32, GPS Antenna, Temperature Monitoring, Power Consumption.

TABLE OF CONTENTS

学位论文原创性声明.....	1
ABSTRACT.....	I
TABLE OF CONTENTS	III
LIST OF FIGURES.....	VI
LIST OF TABLES.....	VI
INTRODUCTION	1
1.1 Background	1
1.2 Current Research Status	1
1.3 Problem Statement	3
1.4 Research Objective.....	4
1.5 Scope and Limitations.....	4
1.6 Research Contribution.....	5
1.7 Organization of this article.....	6
LITERATURE REVIEW	8
2.1 Introduction.....	8
2.2 Internet of Things (IoT) Concept	8
2.3 NB-IoT Communication Technology.....	9
2.4 GPS/GNSS Positioning Technology	10
2.5 Environmental Monitoring Sensing.....	11
2.6 Cloud Based Monitoring Systems.....	13
2.7 Previous Studies.....	13
2.8 Chapter Summary.....	14
SYSTEM DESIGN AND METHDOLOGY	15
3.1 Introduction.....	15
3.2 Overall System Architecture	15
3.7.1 System Overview	16
3.7.2 Data Flow	16
3.7.3 Design Objectives	17
3.3 Hardware Design.....	17
3.3.1 Main Control Board	17

3.3.2	NB-IoT Communication Module	18
3.3.3	GPS/GNSS Module.....	19
3.3.4	Temperature and Humidity Sensor.....	20
3.3.5	Relay Module	20
3.3.6	Power Supply Design.....	21
3.4	Software Design	21
3.4.1	Firmware Architecture	22
3.4.2	Data Processing Logic.....	23
3.4.3	GPS Data Processing	24
3.4.4	Communication Logic.....	24
3.4.5	Dashboard Logic	25
3.5	Communication Mechanism	25
3.5.1	UART Communication	26
3.5.2	Sensor Data Collection and Packet Formatting	26
3.5.3	NB-IoT Communication Process	26
3.5.4	Cloud Communication	27
3.5.5	Complete Communication Flow	27
3.6	System Operational Flowchart.....	28
3.6.1	System Initialization.....	29
3.6.2	Sensor Reading Process	29
3.6.3	Data Processing and Validation.....	29
3.6.4	Data Transmission.....	29
3.6.5	Monitoring Process	30
3.6.6	Repetition Loop and Continuous Operation	30
3.7	Hardware Implementation.....	30
3.7.1	Repetition Loop and Continuous Operation	30
3.7.2	Wiring Integration	31
3.7.3	Power Integration.....	32
3.7.4	Actual Hardware Prototype.....	32
3.8	Software Implementation	33
3.8.1	STM32 Firmware Implementation.....	33
3.8.2	GPS Data Parsing.....	34

3.8.3	AT Command Execution	36
3.8.4	Data Formatting	37
3.8.5	Data Transmission Workflow	38
3.9	Dashboard Platform	39
3.10	System Integration	40
3.10.1	Sensor Monitoring Module	40
3.10.2	GPS Tracking Module.....	40
3.10.3	Data Processing Module	41
3.10.4	NB-IoT Communication Module	41
3.10.5	Cloud Monitoring Module	42
3.11	Chapter Summary.....	42
TESTING AND EVALUATION.....		44
4.1	Introduction	44
4.2	Hardware Testing	44
4.3	NB-IoT Communication Testing.....	45
4.4	DHT11 Sensor Testing	48
4.5	GPS Performance Testing	50
4.6	Power Consumption Testing	52
4.7	Performance Analysis and Discussion	53
4.8	Chapter Summary.....	54
CONCLUSION		55
5.1	Research Conclusion.....	55
5.2	Future Improvement.....	55
REFERENCE.....		57
APPENDICES		61
ACKNOWLEDGEMENT		86

LIST OF FIGURES

Figure 3. 1 Overall System Block Diagram	16
Figure 3. 2 Main Control Board or STM 32 Circuit	18
Figure 3. 3 BC20 NB-IoT Communication Schematic Design.....	19
Figure 3. 4 Schematic of GNSS Antenna.....	20
Figure 3. 5 Part of Schematic and Original DHT11 Temperature and Humidity .	20
Figure 3. 6 Part of Schematic and Real Visualization of Relay	21
Figure 3. 7 Firmware Architecture Overview	23
Figure 3. 8 Data Parsing Logic	24
Figure 3. 9 MQTT Broker Connection Sequence	25
Figure 3. 10 Communication Sequence Diagram	28
Figure 3. 11 System Operational Flowchart.....	28
Figure 3. 12 Prototype Assembly	31
Figure 3. 13 Wiring Integration.....	32
Figure 3. 14 Final Hardware Prototype.....	33
Figure 3. 15 Implementation of GNRMC Data Acquisition from BC20 GNSS Module	35
Figure 3. 16 Latitude and Longitude Conversion Process	36
Figure 3. 17 BC20 Initialization and Network Attachment Procedure	37
Figure 3. 18 JSON Payload Construction for MQTT Transmission.....	38
Figure 3. 19 MQTT Payload Transmission to OneNET Platform	38
Figure 3. 20 CMIOT Dashboard Displayed.....	40
Figure 4. 1 SSCOM Serial Monitoring Displaying Data Transmission Testing	47
Figure 4. 2 Testing Setup Showing the DHT11 Sensor Positioned in each of the Fie Test Environment During Sensor Observation Testing.....	49
Figure 4. 3Outdoor GPS Testing Setup.....	51

LIST OF TABLES

Table 2. 1 Comparison of Wireless Communication Technologies for IoT Application.....	9
Table 2. 2 Standard Temperature and Humidity Requirement for Cold Chain Products.....	11
Table 2. 3 Technical Specification of The DHT11 Sensor	12
Table 3. 1 Key Specification of The BC20 Module.....	18
Table 4. 1 Hardware Component Testing Results	45
Table 4. 2 NB-IoT Communication Testing Results	48
Table 4. 3 DHT11 Sensor Reading Across Five Environmental Conditions	50
Table 4. 4 GPS Testing Result.....	51
Table 4. 5 Power Consumption Testing	52