PROJECT SOMNUS: SLEEP SYSTEMS TECHNOLOGY

SUPERIOR INNOVATION TO ALTER SLEEP DEPRIVATION

A PROJECT MANAGEMENT PLAN

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Project Sponsor:	Ronnie Paguia
Current Version:	2
Previous Versions:	NA
Projected Start and End Dates:	

About

This comprehensive proposal builds on the Connected Environments Initial Project Proposal for the implementation of an IoT system within the context of the health and wellness of the population. It demonstrates the value of the proposed system which includes the organisational, customer, community, social, ethical, and sustainability impacts, assessing its inherent risks, and how this proposal fits within the NZ policy and data security in consideration of circular economy and sustainability.

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Introduction

According to World Health Organization, people live longer, with most people expecting to live into their sixties and beyond. Growth in size and the proportion of older persons in the population are experienced across every country globally. By 2030, the population aged over 60 years will increase from 1 billion to 1.4 billion, doubling by 2050 to 2.1 billion, while the number of persons aged 80 years or older will reach 426 million ("Ageing and Health", 2021).

The global population's dynamics have raised concerns about the future of the worldwide healthcare system's sustainability. With the proportion of older people aged 60+ continuously increasing, chronic-degenerative disease incidence and higher health care demand and spending for health and social care are expected (Lopreite et al., 2017). New Zealand is not the only country addressing the impact of an aging population. Many other countries face the issue this may bring on the provisions and demands for health care and disability services (Ministry of Health, 2002). Furthermore, it has been reported that the growing, ageing and diverse population with the increasing prevalence of long-term conditions and disability imply a harder-to-sustain approach to health care which would require a shift that focuses more on prevention and wellness, harnessing new technologies (Ministry of Health, 2017).

Sleep is essential for the health and wellness of the population. It is a common complaint among adults, and as this population increases, the prevalence of sleep disturbances also increases. It has significant consequences, including poor physical and mental health-related quality of life (Miner & Kryger, 2017). Sleep is vital for mental and physical development. Assessment of sleep quality, therefore, is important for health and wellbeing (Şimşek, et al., 2019). The bedroom environment can have a significant influence on sleep quality and quantity. Light, temperature, and noise are the three main environmental factors that impact sleep ("External Factors that Influence Sleep", 2021). Thus, a reliable continuous monitoring system is required to analyse sleep quality.

The emergence of IoT technology has provided a promising opportunity to build a reliable sleep quality monitoring system by leveraging the rapid improvement of sensor and mobile technology. However, when talking about IoT, Data acquisition (DAQ) and protocols are fundamental building blocks of IoT technology. A data acquisition device helps users make machines smarter by gathering and analysing real-time data. IoT protocols enable it to exchange data in an organised and significant manner. It can be designed using promising solution technologies such as Machine Learning to develop efficient and sophisticated algorithms to project future trends and Cloud technology that provides robust, scalable, and flexible high-performance computing, storage, and software services at low cost.

This Project Management Plan (PMP) aims to leverage this technology for disease prevention and promotion of physiological wellbeing of an ageing population, keeping younger people healthier as they age thereby reducing primary health care needs. A more detailed analysis of the stakeholders is summarised in the following Lean Canvas. It organizes the proposed IoT project for efficient and more effective resource allocation decisions. Important project details of its purpose, defined scope, and the parameters are also being communicated, serving as an addition to a broader plan for exploiting disruptive technology. A high-level project timeline is proposed along with a ballpark estimate of the cost as key factors affecting the IoT pricing strategy. The paper will be concluded by presenting some ethical concerns on privacy and security, governance, a risk assessment and a corresponding proposed mitigation process, and the technology's social and global impact.

1 Business Plan Summary

1.1 Problem Statement

Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%. By 2020, the number of people aged 60 years and older will outnumber children younger than 5 years. In 2050, 80% of older people will be living in low- and middle-income countries. All countries face major challenges to ensure that their health and social systems are ready to make the most of this demographic shift ("Ageing and health", 2021).

1.2 Solution Overview

The proposed solution utilises technology for disease prevention and promotion of physiological wellbeing of an ageing population, keeping younger people healthier as they age thereby reducing primary health care needs. It promotes the well-being of the population and will prevent diseases by improving the quality of sleep using simple approaches such as the prevention of sleep deprivation by installing automated HVAC control systems to improve indoor comfort and wellness, automated light switches and installation of improvised lamp that helps increase sunlight exposure, as well as noise cancellation system to mitigate unnecessary noise thereby promoting sleep improvement in terms of quantity and quality.

1.3 Unique Selling Proposition

The IoT system uses environmental sensors and sleeps detection methods to improve sleeping quality. Using environmental sensors in identifying better sleeping conditions, an algorithm will be developed to estimate sleeping patterns and provide visualization to optimise sleep. Through this project, people become more aware of their sleeping patterns and increase their sleep quality for a more active daily life.

IoT HVAC Smart Solution. The algorithm used in this infrastructure provides proper control actions in optimizing thermal comfort and energy efficiency. The works of Carli et al. (2019) show that this system guarantees indoor comfort and significant energy savings in the face of multiple disturbances. Although the energy efficiency of HVAC systems serves as a critical goal of this system, the application of automatic techniques would primarily contribute to promoting good quality sleep resulting in the general health and well-being of home users.

IoT Intelligent Lighting. The system has substantial benefits for a more intelligent home, including robust security and lower cost. On top of this, the ability to assess and measure the actual sunlight exposure and the designed automation to ensure that the required sunlight exposure is achieved allows for the improvement of sleeping quality for the population, demonstrating the great potential of this digital technology (Khoa et al., 2020).

IoT Noise Measurement and Cancellation. The system is designed as low-cost, with an easy to construct sensor node that allows for easy replication for extension of the sensor network. Anachkova et al. (2020) believe the system provides high performance in measurement accuracy (5 dB maximum). Ultimately, the goal is to deliver a more extensive scale network of common sensors to monitor sound levels continuously. Thus, a noise change visualization contributes to a better understanding of environmental noise that helps with the innovative city development and provides an opportunity to address any negative implications to promote the general health and wellbeing of the population.

The proposed IoT system offers significant benefits not only to its users but to the global community as well. Decreasing the cost of health care is a huge benefit, added to that is the improved quality of life.

1.4 Review of Competition

Direct Competitors

Smartlife offers a wide range of IoT solutions - from the Smartlife Pro packages to Custom Design for luxury homes. Smartlife currently offers home technology that includes Smart Lighting System and Energy, Solar & EV Charging among others but does not offer any Noice Cancelling Solutions which makes this proposed IoT system competitive.

Trust Smart Home is a leading European partner for Home Automation & Digital Lifestyle Accessories, operating for more than 30 years with distributing office in Auckland. They offer a Trust Smart Home Wireless home automation system that combines products to automate lighting and devices and create a cozy, safe, and energy-efficient home. Currently, nothing is being offered for HVAC control or Noise Cancelling. Hence, the proposed IoT system is given a massive opportunity for market penetration.

Potential Competitors

Spark New Zealand connects New Zealand businesses to technology that could help them become more productive and sustainable. With Spark's already established partnerships with IoT experts ready to identify the opportunities and plan & deploy similar IoT solutions and one-stop-shop IoT solutions, including hardware, connectivity, data analytics and insights and after-sales support, it is obvious it has the potential to become a direct competitor.

Datacom has over 6,200 people and annual revenues of over $1.2 billion, making it a large professional IT services company with expertise in contact centres operations, data centres, IT services provision, software engineering and application management, and payroll and customer service design and operations. It has the capacity and ability to provide a substitutable IoT solution.

Indirect Competitors

Some indirect competitors identified include manufacturers and distributors of the HVAC appliances, lamps and lighting, speakers and microphones, wearables devices, personal equipment such as laptops and desktops, etc. These entities provide solutions to the sleeping problem and may also help improve the quality of life.

2 Project Management Plan (PMP)

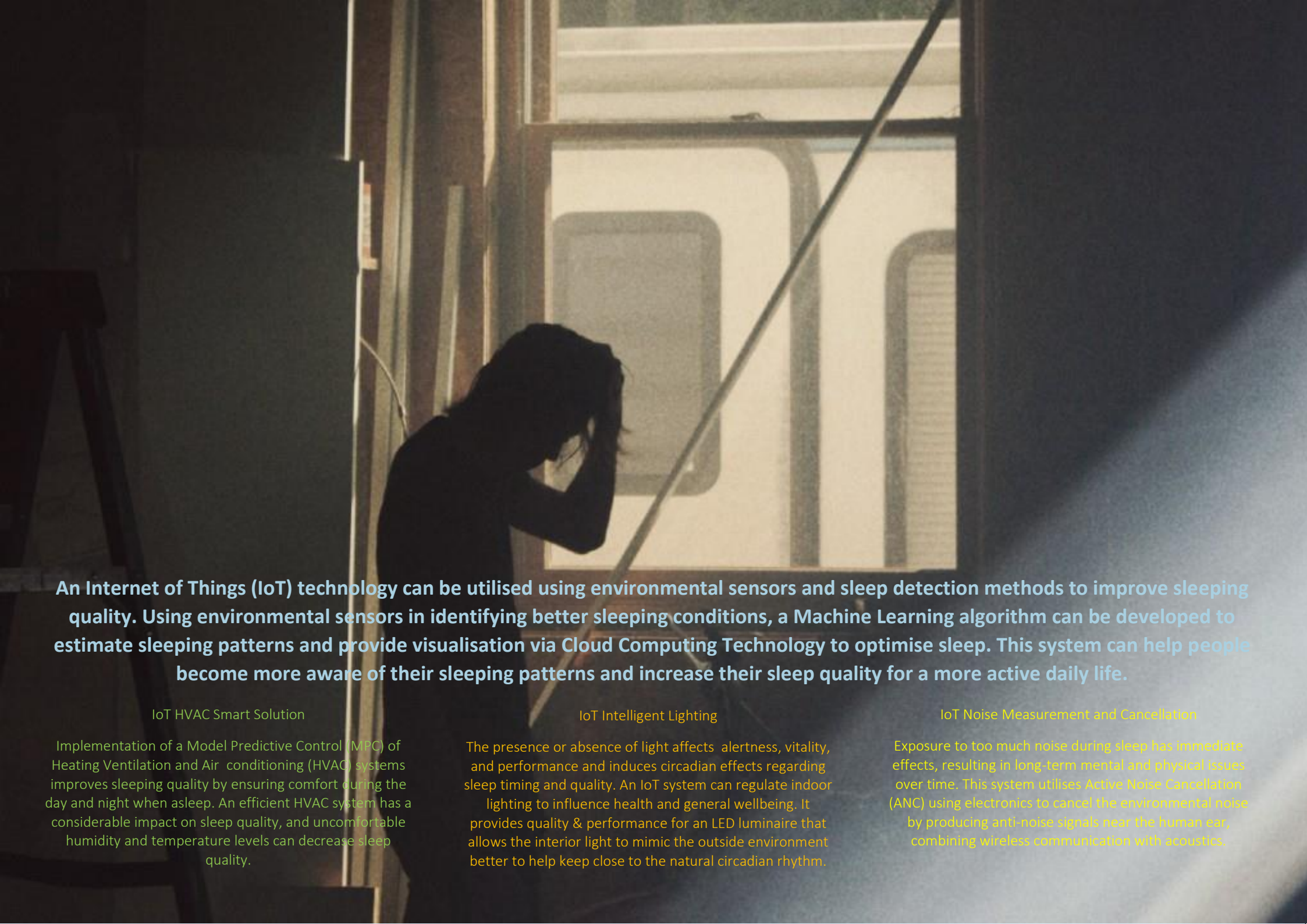
2.1 Purpose of the PMP

This document is to provide a reference for the project team involved in the planning and delivery of Project Somnus (Latin "Somnus" meaning Sleep). It outlines the project scope, project budget, project risks, communication strategy and roles within the project team and responsibilities of individual team members. It aims to define project delivery methodology and team structure and to provide clarity and guidance for the project delivery by individual team members. It intends to support the delivery of a high-quality product while achieving the project cost and programme objectives.

2.2 Project Scope and Deliverables

Improving the quality of sleep hopes to promote the well-being of people and the prevention of diseases. This shall be through delivering the following:

i. Prevent sleep deprivation by installing automated HVAC control systems to improve indoor comfort and wellness
ii. Automated light switches and installation of improvised lamp that helps increase sunlight exposure.
iii. Design of noise cancellation system to mitigate unnecessary noise thereby promoting sleep improvement in terms of quantity and quality.



An Internet of Things (IoT) technology can be utilised using environmental sensors and sleep detection methods to improve sleeping quality. Using environmental sensors in identifying better sleeping conditions, a Machine Learning algorithm can be developed to estimate sleeping patterns and provide visualisation via Cloud Computing Technology to optimise sleep. This system can help people become more aware of their sleeping patterns and increase their sleep quality for a more active daily life.

IoT HVAC Smart Solution

Implementation of a Model Predictive Control (MPC) of Heating Ventilation and Air conditioning (HVAC) systems improves sleeping quality by ensuring comfort during the day and night when asleep. An efficient HVAC system has a considerable impact on sleep quality, and uncomfortable humidity and temperature levels can decrease sleep quality.

IoT Intelligent Lighting

The presence or absence of light affects alertness, vitality, and performance and induces circadian effects regarding sleep timing and quality. An IoT system can regulate indoor lighting to influence health and general wellbeing. It provides quality & performance for an LED luminaire that allows the interior light to mimic the outside environment better to help keep close to the natural circadian rhythm.

IoT Noise Measurement and Cancellation

Exposure to too much noise during sleep has immediate effects, resulting in long-term mental and physical issues over time. This system utilises Active Noise Cancellation (ANC) using electronics to cancel the environmental noise by producing anti-noise signals near the human ear, combining wireless communication with acoustics.

3 The IoT Project Team

Three teams will be formed to look after the three solutions: HVAC Smart Solution, Intelligent Lighting Systems, and the Noise Cancelling Solution. Every time will comprise of 2-4 members serving in one or more of the following functions:

- Design Lead heading the interaction design and the product evaluation
- Development Lead that heads the building and programming of product
- Business Lead that spearheads business analysis, and product marketing
- Project Manager leading team for a successful project delivery

For a team of 2 members, one person to be designated as the Design Lead who will also serve as the Business Lead. The other will be the Development Lead who will also function as the Project Manager.

A team of 3 is to distribute the function as Design Lead, Development Lead, and the Business Lead. Somebody among the team will also function as the Project Manager.

Teams of 4 will have each person assigned to each role.

Additional specialist roles will be sourced on a contractual basis and as per need basis.

4 Meeting Schedule

The communication strategy shall be as follows:

Size	Frequency	Time	Meeting Activity
Small	Yearly	One day	A one-day meeting to run through the project delivery achievement
Medium	Quarterly	Seven days	Two days to run through Design Phase. A third day to complete Prototypes, a fourth day to complete the Project Specifications, and three days to plan the pilot and implementation (Deployment, Communication Plan, Training).
Large	Monthly	Two + days	Monthly with additional meetings for prioritized initiatives. Week-long retreats for formal analysis, planning and integration with all disruptive technologies
	Weekly	1 day	Weekly Stand-up Meeting (15 mins)

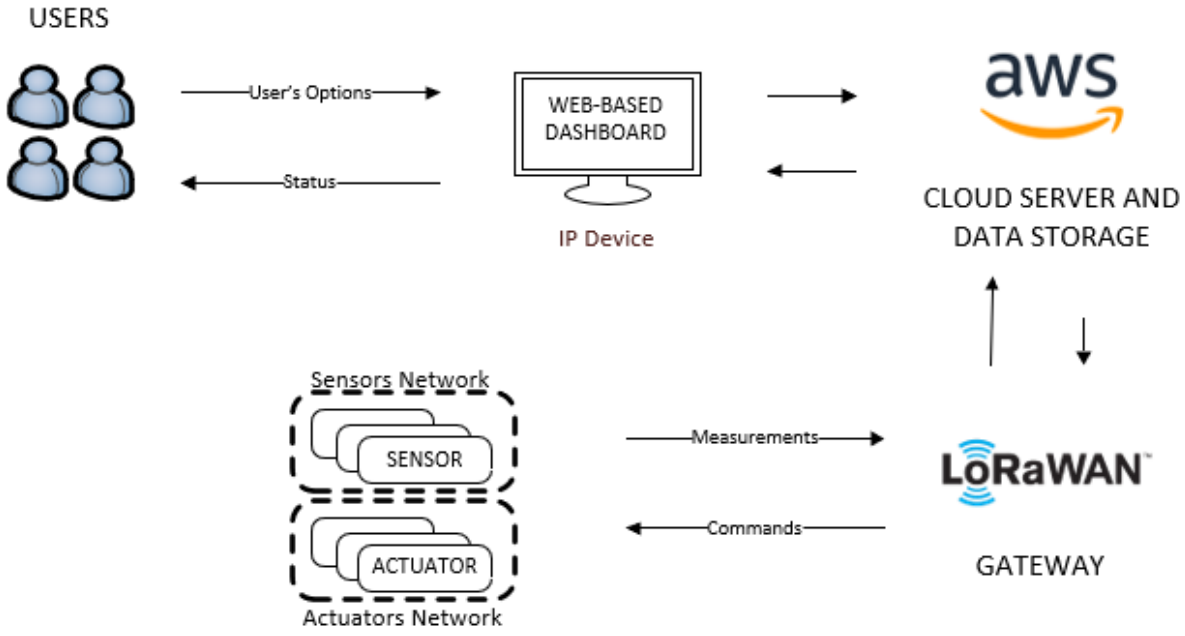
Initial Executive Approval

Executive Approval for the IoT Project Team	
Name and Title	Signature

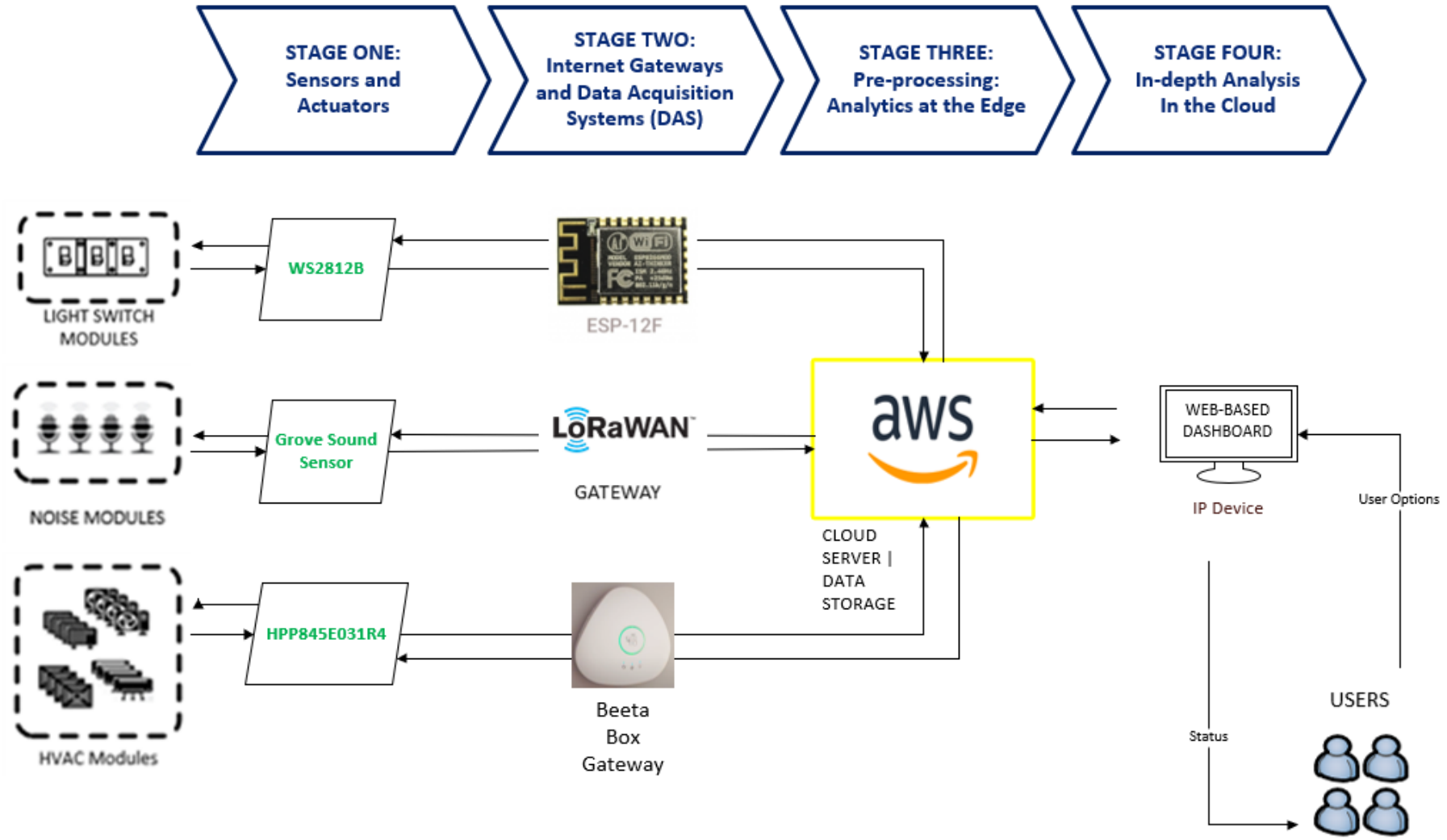
5 Technology

5.1 System Architecture

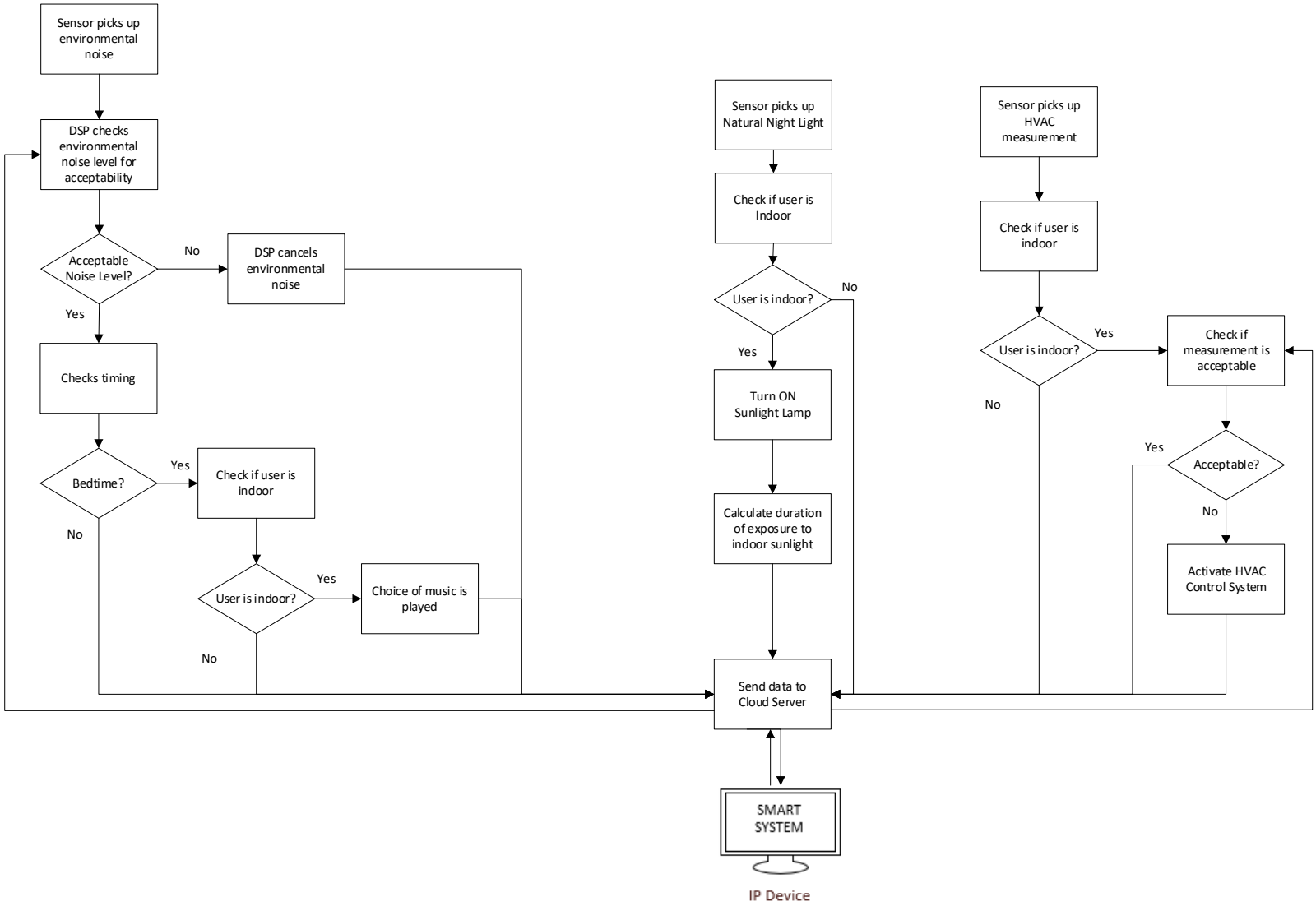
The high-level system diagram comprises a net of sensors that perceives the environmental conditions including the temperature, natural light, and sound whose measurements sent to a gateway; a net of actuators that control the system modules (HVAC, Light Switch, Noise) and communicate with the gateway, a gateway (LoRaWAN) that connects the nets of sensors and actuators to the Internet, an external database server (AWS) that collects/ forwards data from/ to the field and from/ to the control unit and where the algorithms are executed, and a web-based IP device that acts as the end-user interface and functions as the control unit that communicates with the database server and hosts a dashboard dedicated to monitoring the state of the environment and setting the control system mode. This tool (see Section 5.9 Data Visualisation) will integrate the three solutions into a single product offering, helping to visualize the output to monitor sleeping patterns and results to get actionable insights, providing a quick and effective way to communicate information on user behaviours, and allow the ability to rapidly and effortlessly make decisions affecting health and wellness.



5.2 System Technology Stages



5.3 System Technology Flow



5.4 IoT Platform

Amazon Web Services (AWS) shall be used as the IoT Platform that offers a broad set of cloud-based products allowing for the easy connection, collection, storing, and management of sensor data to the cloud; providing features including Compute, Storage, Databases, Analytics, Networking, Mobile, IoT security, and On-demand with pays-as-you-go pricing.

Compared with other IoT platforms (Google Cloud IoT, Salesforce IoT Cloud, Microsoft Azure IoT Hub, etc.) available in the market today, the following are the identified advantages of the recommendation relative to its application.

Pros	Details
Economies of scale	To pay only as per what has been used
More efficient capacity management	Easy and optimal management of required capacity
Increased speed and agility	New IT resources are a click away
Reduced spending on data centres maintenance	Allows for focusing on customers
Faster Global deployment	Easily deployed application in multiple regions worldwide

5.5 Selecting the IoT Hardware

Flexibility and the capacity to operate in iterative scenarios were considered in selecting the following pieces of hardware programmed for applications that can transmit data over the internet.

Category	HVAC	Light	Noise
Building Blocks	▪ Kogan SmarterHome™ Smart Gateway & Security System Sensor Kit (Bluetooth Mesh)	▪ Kogan SmarterHome™ IR Universal WiFi Remote Controller	▪ Seeed Indoor Gateway XNM1AS923 SenseCAP M1 Helium Indoor HotSpot, HNT Miner AS923 LoRaWAN ▪ StarTech.com Cisco SFP-10G-SR-S Compatible SFP+ Transceiver Module - 10GBASE-SR ▪ Dayton Audio DSP-408 4x8 DSP Digital Signal Processor Home Audio
Sensors	Sensing modules, RF modules		
Basic Devices	Desktop, Tablet, Cellphone, routers, switches, Speaker, Sunlight Lamp, HVAC, Microphone, LED		
Wearable Electronic Devices (Optional & for Future Release)	Wristwatch (temperature measurement)	Wristwatch	Ear-device

5.6 Selecting the IoT Software

An initial indication of the software and programming languages to be used for the development of the IoT system are as follows:

1. MATLAB Function (quadprog) to solve the quadratic optimization problem required to implement HVAC Smart Solution.
2. JavaScript, HTML, CSS, C++, Python 3 to be used to develop the Smart Intelligent Lighting system.
3. The measured data related to the noise cancellation application will be processed using MATLAB for a more detailed data analysis if needed.

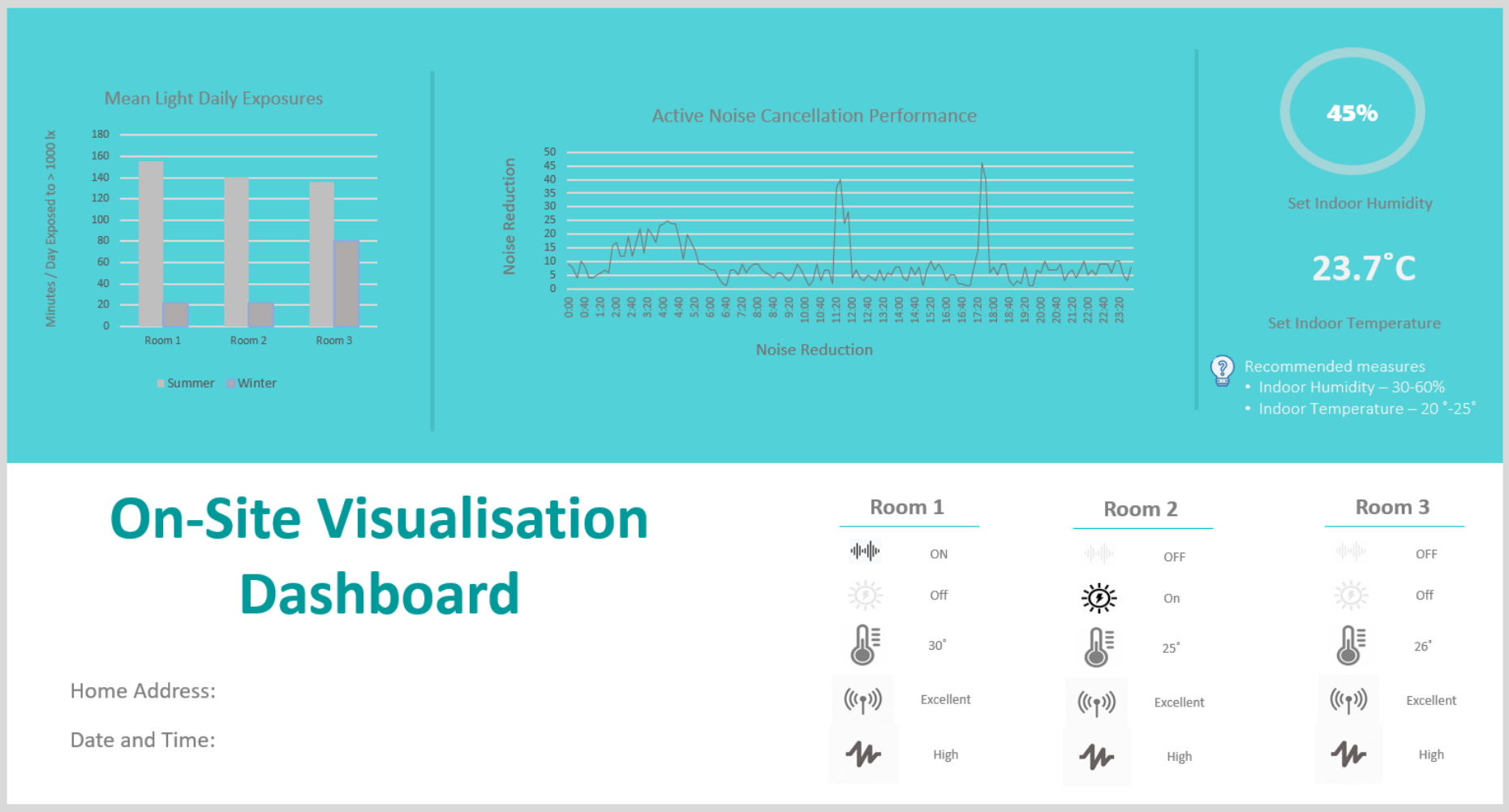
5.7 Communication Protocol

Communication Protocol	Standard	Frequencies	Range (approx.)	Data Rates	Reason for Consideration
Wi-Fi	Based on IEEE 802.11n (Commonly used in Homes today)	2.4 GHz and 5 GHz bands	50meter up to 100 meters	600 Mbps max	The fast data transfer, capability to process a big amount of data, and suitability within LAN environments, with short- to medium-range distances, were considered for real-time monitoring and motion detection.
Cellular	GSM/GPRS/EDGE(2G), UMTS/ HSPA (3G), LTE (4G)	900/ 1800/ 1900/ 2100MHz	35km max for GSM, 200 km max for HSP	35-170 kbps	Leveraging on the wide availability and well-known options for IoT applications. This will be an optional medium for the user to access the Smart System (Dashboard).
Bluetooth	Bluetooth 4.2 core specification	2.4 GHz (ISM)	50-150 meter (Smart/ BLE)	1 Mbps (Smart/ BLE)	Bluetooth is a low-power, short-range wireless technology using short-wavelength UHF radio waves which can be utilised for noise detection and other deployments
LoRa and LoRaWAN	LoRaWAN	Various	2.5 km (Urban environment), 15 km (Suburban environment)	0.3 to 50 Kbps	Longer-range communications capabilities to be used specifically for detecting environmental noise (traffic from the exterior building)

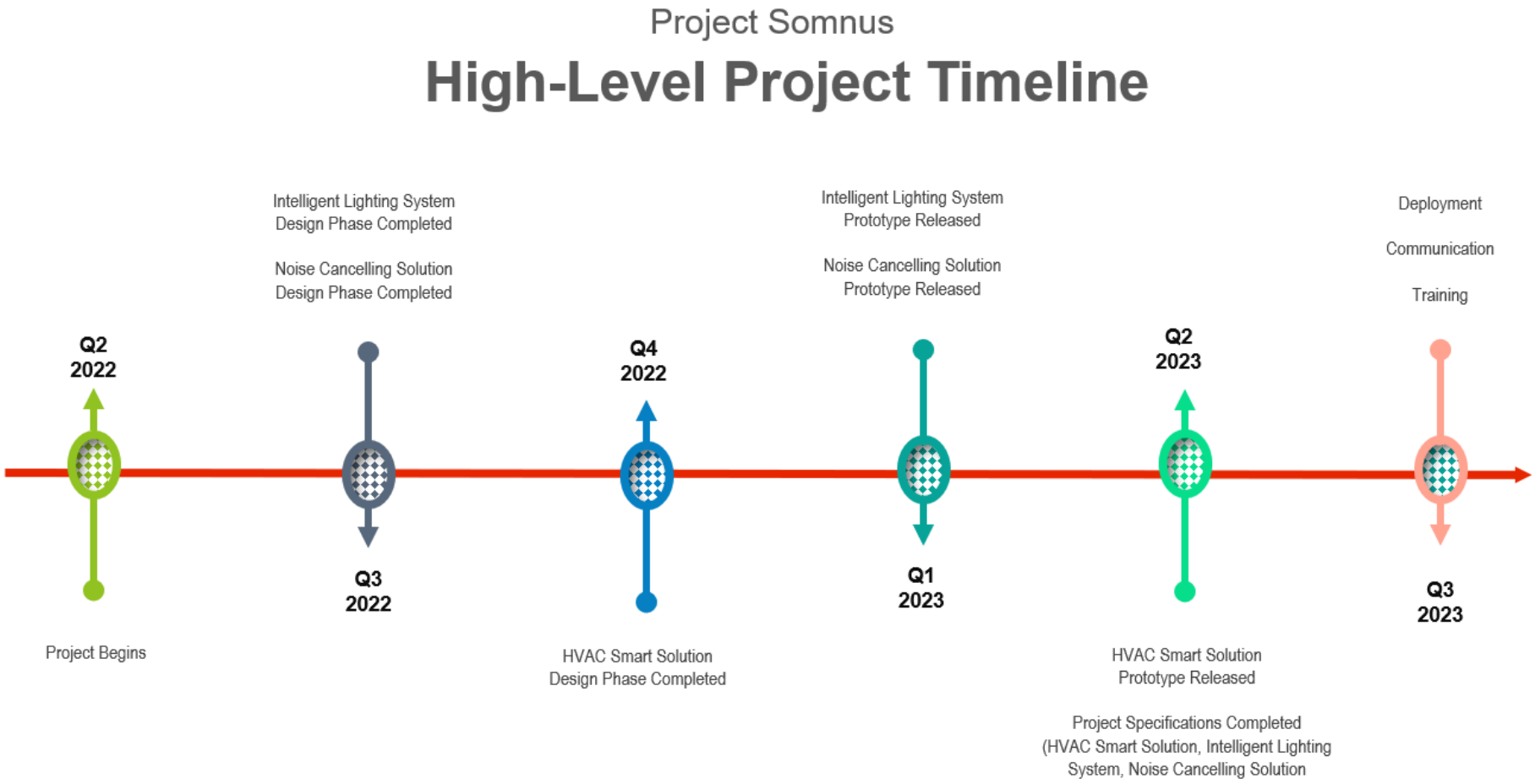
5.8 IoT Analytics

IoT Sensor Data Type	**Collected Data**	**Collection Process**	**Data Processing**
Status Data	Captured movement	Motion sensor to detect any movement indoor via camera sensor, an illuminance sensor, or temperature sensor	Information is sent to AWS Cloud Server which will then transmit the command to microcontrollers accordingly
Automation Data	Natural night light	Sensors on the circuit pick up natural night light and send these data to microcontrollers installed on each lightbulb	Processed by ESP8266-12F microcontroller sent to AWS Cloud Server, the date will then transmit commands to the bulb (lighting bulb and Sunlight Lamp) to either turn it ON/OF or deliver healthy natural indoor light
Automation Data	Outdoor noise level	Continuous data collection via noise measuring system constructed of a microprocessor, microphone, battery and information transfer module Microphone sensitivity at 1 kHz is 2-48 dB with an acceptable noise level from 42 dB to 90 dB	Processed by Arduino Uno microcontroller which will then be sent via LoRa click module to AWS Cloud Server for storage, and then visualized via Smart System.
Automation Data	Temperature and Humidity level	Sensors are installed indoors to receive environmental conditions and measurements	Beeta Box receives data from sensors and sends information to AWS Cloud Server; the MPC algorithm runs within the AWS Cloud Server which provides input for the control algorithm using measured data and weather forecast information

5.9 Data Visualisation



6 Milestones



7 Cost & Pricing Strategy

7.1 Pricing Strategy

Capital Investment	Operational Cost
$1,567,610.13	937,759.39

Number of Subscribers (annual)	747
Initial Investment	
Infrastructure:	
Hardware devices	
Building Blocks per Household of 3 bedrooms	$ 2,098.54
Basic Devices per Household of 3 Bedrooms	2,422.83
Cloud Services (Annually)	22,759.39
Technical Skills:	
Design Lead	225,000.00
Development Lead	210,000.00
Business Skills:	
Project Manager	270,000.00
Business Lead	210,000.00

Specialist Skills (as per need basis):	
Accounting	*$ 60,000.00*
Cloud Services Specialists	*120,000.00*
Hardware Devices Specialist	*60,000.00*
AI and Data Engineers	*60,000.00*

Pricing Model		
Subscription		
Monthly Subscription Cost	$	30.47
Margin @ 100%		30.47
Monthly Subscription Fee		60.94
Repayment of Hardware Device	$	174.88
Margin @ 25%		43.72
Hardware repayment total	$	218.60
Total Subscription Cost per Month	**$**	**279.53**

NOTES:

Subscription Locked In		**12**
Total Hardware Device Cost per Household	$	2,098.54
Total Subscription Cost per Household for 12 months	$	365.61
Calculated Monthly Device Cost per Household	$	174.88
Calculated Monthly Subscription Cost per Household	$	30.47
Total Cost per household per month	$	205.35
Target No. of Subscriptions per year		**747**
Projected Revenue from Subscriptions per year	$	2,505,738.02
Calculated Cost from Subscriptions per year	$	1,840,722.81
Estimated Gross Profit from Subscriptions per year	$	665,015.21

Projected Revenue from Subscriptions per year	$	2,505,738.02
less: Capital Investment	$	1,567,610.13
less: Operational Cost	$	937,759.39
Project Income	$	368.50
Number of Subscribers to Break-even		**747**

7.2 Procurement Strategy

The components and hardware that will be needed will mostly be sourced off-the shelves (JB Hi-Fi, PB Tech) while some will be sourced from Digi-key which exclusively distributes electronic components.

Specialist skills will be outsourced as per need basis. In particular, the requirement for Hardware Device Specialist will be required during installation any cost incurred will form part of the installation fee.

Device	Qty	COST, NZ$				
		HVAC	Light	Noise	Basic Devices	Image
Building Blocks						
Kogan SmarterHome™ Smart Temperature & Humidity Sensor (3 Pack, Bluetooth Mesh)	1	39.99				
Kogan SmarterHome™ IR Universal WiFi Remote Controller	1		31.99			
Natural Sunlight Desk Lamp, Adjustable Gooseneck by Lavish Home, Black	3		90.00			
Seeed Indoor Gateway XNM1AS923 SenseCAP M1 Helium Indoor HotSpot, HNT Miner AS923 LoRaWAN	1			961.18		
StarTech.com Cisco SFP-10G-SR-S Compatible SFP+ Transceiver Module - 10GBASE-SR	1			426.55		
Dayton Audio DSP-408 4x8 DSP Digital Signal Processor Home Audio	1			471.50		
JBL Link Music WiFi Smart Speaker - Blue - with Bluetooth				74.98		
Knowles analog microphone for far-field IoT and ANC Ear applications	3			2.35		
Basic Devices						
PB Jupiter 51150 Windows 10 Pro Mini Business PC, AMD Ryzen 5 5600G 6 Core / 12 Threads up to 4.4Ghz, 16GB DDR4 , 500GB NVME SSD,VGA/HDMI/ DisplayPort, 6 X USB , 2 X USB-C , Windows 10 Professional, VESA Mount support, WiFi AX + BT, TPM 2.0	1				1,378.85	
Microsoft Surface Go 3 Tablet - 10.5" - Intel Pentium 6500Y Processor - 4GB Ram - 64GB SSD - WiFi - Win11 Home in S Mode	1				694.99	
Samsung Galaxy M22 (2021) Dual SIM Smartphone 6GB+128GB - Black - 90Hz AMOLED display, 48MP Quad Camera, 5000mAh battery	1				348.99	
GRAND TOTAL		$ 39.99	$ 121.99	$ 1,936.56	$ 2,422.83	$ 4,521.37
Percentage Cost Contribution (not including basic devices)		2%	6%	92%		

8 Finalisation and Support

8.1 Ethics

The successful delivery of Project Somnus is filled with optimistic views of a happier and healthier population. This entails numerous changes, some positive and some negative and many unintended. The proposal will deliver greater automation, increased convenience and remarkable efficiency gains. However, the proposed technology will deliver new challenges and problems around security, privacy and how its subscribers will go about living their digital lives.

8.2 Data Privacy

Data privacy would be a primary concern for implementing the proposed IoT system. The sensors and smart devices will be acquiring a lot more information from people – what

they do, when, where and how. The person who has access to those data and what they can do with it will also be considered.

Setting up a security measure on the IoT Network will help avoid cyberattacks. Antivirus, Anti-malware and firewalls shall be used as the bare minimum. Additionally, ensuring that data are encrypted at both rest and in transit between IoT devices will help protect users' privacy and prevent data breaches.

8.3 Data Security

All personal data, including credit card numbers, could be stolen by hackers breaking into the network. People's behaviour or physical activities are information that hackers may use to find a lucrative aftermarket. Every bit of data is valuable to someone, which might make it worth stealing. Hackers can break into the smart lighting and security system to kill all the lights (and alarms) and unlock all the smart doors (if integrated into the IoT system) in preparation for a robbery. Or someone with even more malicious intent turning the heating/ cooling system against the occupant by cutting off airflow or inducing dangerous gases into the system. Maintaining a separate Wi-Fi network for the appliances and primary devices can prevent hackers from directly accessing sensitive information stored in smartphones, laptops, etc.

8.4 Big Data Issues

So much data will be collected that having the time, the facilities, or the computational power to analyse it could bring some issues, ending up collecting data for data's sake and never doing anything with it. Utilising AI to find better ways of securing the IoT Network. Architected security solutions shall include the automated discovery and classification of the IoT devices themselves, flagging abnormalities in IoT device behaviour, anomalies detection, and the enforcement of security policies are just some of the measures that need to be incorporated into the solution.

8.5 Autonomy and Control Issues

Communicating with other self-regulating appliances across the network and sharing information about their processes opens questions relevant to governance. How autonomous the devices will be, is a matter of consideration relative to culture and human perception. The more control ceded to these devices and machines, the less is felt of being still in control which may lead to the feeling of vulnerability and even inferiority to some degree.

Providing services in which humans will still be required to analyze, i.e., when the machine maintenance should be performed; and providing the ability to package judgment and reasoning into software applications and devices, will create opportunities to lessen moral dilemmas and thus increase self-esteem indicating the importance of "human control".

8.6 Governance

Governance Role	Responsibility
Cabinet Ministry (Infrastructure, Energy and Resources, Research, Science and Innovation, Public Service, Social Development and Employment, Disability Issues, Finance, Housing, Health, Environment, Building and Construction, etc.)	Legislator
Building Consent Authority (BCA)/ Territorial Authority (TA)	Regulator
IoT Project Manager	Owner
IoT Business Lead	Stewards
IoT Administrators	Operators

9 Social Impact

9.1 Sustainability

The proposed IoT system offers significant benefits not only to its users but to the global community as well. Decreasing the cost of health care is a huge benefit, added to that is the promotion of good health, well-being, and improved quality of life.

IoT HVAC Smart Solution. The ability to reduce CO2 emissions by regulating indoor temperature more effectively helps combat climate change and protect the environment. This is exactly why the proposed sleep systems technology was designed – to impact sustainability through energy efficiency.

The algorithm used in this infrastructure provides proper control actions in optimizing thermal comfort and energy efficiency that guarantees indoor comfort and significant energy savings in the face of multiple disturbances. Although the energy efficiency of HVAC systems serves as a critical goal of this system, the application of automatic techniques would primarily contribute to promoting good quality sleep resulting in the general health and well-being of home users.

IoT Intelligent Lighting. The system has substantial benefits for a more intelligent home, including robust security and lower cost. On top of this, the ability to assess and measure the actual sunlight exposure and the designed automation to ensure that the required sunlight exposure is achieved allows for the improvement of sleeping quality for the population, demonstrating the great potential of this digital technology.

With suicide rates at record levels and younger generations increasingly unhappy with life, recent studies indicate that the use of smartphones and similar devices is largely to blame

for deteriorating mental health. However, studies have shown that adequate exposure to natural light improves mental health, and this is what Project Somnus has set out to accomplish.

IoT Noise Measurement and Cancellation. The system is designed as low-cost, with an easy to construct sensor node that allows for easy replication for extension of the sensor network providing high performance in measurement accuracy (5 dB maximum). Ultimately, the goal is to deliver a more extensive scale network of common sensors to monitor sound levels continuously. Thus, a noise change visualization contributes to a better understanding of environmental noise that helps with the innovative city development and provides for an opportunity to address any negative implications to promote the general health and wellbeing of the population.

9.2 Risk Assessment

Risk and Issue Identification. Project risks and issues will be identified, assessed and managed with good project management practice as set out in the Australian / New Zealand Standard on Risk Management (AS/NZS 4360:2004) and PMBOK. The following processes will be adopted to manage risks and issues on the project:

1. Identify potential risks and issues, how, when, where and why they could occur.
2. Analyse risks and issues determining the consequences and their likelihood.
3. Evaluate risks and issues and assess the potential benefits against the negative outcomes.
4. Establish and apply strategies to manage individual risks and issues with the aim of minimising negative effects and maximising potential benefits.
5. Regularly review risks and issues (frequency as detailed in section 3).

   All risks and issues are recorded in the Risk and Issues Register populated for the project.

Risk and Issue Mitigation. The Risk and Issues Register will be used to record all identified risks and issues, rate the items in terms of their potential impact on the project, and identify and record mitigation measures to manage them.

The register will initially be populated via project team input at the team meetings. All stakeholders associated with the project may raise new risks and issues. This can be done by emailing the Project Manager with the description of the new risk/issue. If the new issue requires an urgent response, it will be categorised by the Project Manager, assigned and communicated to the person responsible. If it is a non-urgent issue, it will be categorised and assigned to a person responsible at the next project team meeting.

The risk and issues register will be reviewed in the Weekly Stand-up Meetings and updated throughout the project. Most of the changes that occur in the project will be expected to have originated from the risks or issues registered. All changes must be approved by the Project Manager.

Risk and Mitigation Analysis. An initial risk assessment for this project was performed and the result of which is presented in Appendix B.

9.3 Global Impact

The proposed IoT system is projected to cater for the entire population of all ages - its impact on the global community is therefore significant. This implies that economic gains in terms of cost savings and enhanced productivity growth are enormous such that huge savings will be realised through cost-savings from preventative healthcare, more energy-efficient homes, or from improved healthcare systems i.e., remote monitoring of patients by the population using the system as well as by the government that looks after the healthcare system for the benefit of the population.

Technology may be why the quality of sleep of most people is impacted by disrupted circadian rhythms and interrupted sleep patterns. However, harnessing the power of technology may also be relevant to addressing sleep deprivation and improving the quality of sleep. When designed efficiently, Smart homes not only provide convenience but could also promote health and wellness. Insights obtained from sensed data, when analysed, processed and harnessed, can be beneficial in monitoring and altering the way we live to become better and healthier that stand to exhibit a huge impact on society and the entire planet.

9.4 Next Step

As part of Project Somnus' procurement strategy, a review of the current cost structure will be the focus on the next review, particularly on devising a strategy to lower down the cost of implementing the Noise Cancellation solution. Currently, the solution stands at 92% share of the proposed IoT system's total system cost (see Section 7.2). We are eyeing to source 50% (~$ 968) cheaper yet of same quality gateway and transceiver to bring down the noise cancellation solution's total cost contribution to 86%.

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Appendix A

Lean Canvas

<table>
<tr><th colspan="2">The What</th><th>The Who</th></tr>
<tr><td colspan="2">1. PROBLEM
Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%. By 2020, the number of people aged 60 years and older will outnumber children younger than 5 years. In 2050, 80% of older people will be living in low- and middle-income countries. All countries face major challenges to ensure that their health and social systems are ready to make the most of this demographic shift ("Ageing and health", 2021).

3. SOLUTION
Utilize technology for disease prevention and promotion of physiological wellbeing of ageing population, keeping younger people healthier as they age thereby reducing primary health care needs.</td><td>2. MAIN CUSTOMERS
Adults population 20-40 age group
Adults population 41-59 age group

4. EARLY ADOPTERS
Teens ages 15-19 age group
Older population 60+ age group
Aged Care Home Residents</td></tr>
<tr><th colspan="3">The How</th></tr>
<tr><td colspan="3">5. APPROACHES
Promotion of the wellbeing of people and prevent diseases through improving the quality of sleep
a. Prevent sleep deprivation by installing automated HVAC control systems to improve indoor comfort and wellness.
b. Automated light switches and installation of improvised lamp that helps increase sunlight exposure.
c. Design of noise cancellation system to mitigate unnecessary noise thereby promoting sleep improvement in terms of quantity and quality.
d. Health monitoring system using wearables
e. Mitigate apnea problems through pillow

6. DATA VALUE
Data acquired from household appliances and smart devices performed by IoT protocols, as well as personal and highly sensitive data will be managed within the IoT system. The insights obtained from sensed data, when analysed, processed and harnessed, can be beneficial in monitoring and improving the well-being of people, and can even alter the way of living to become better and healthier.</td></tr>
</table>

Appendix B

Risk and Issue Register – Project Somnus

Risk and Issue Register - Project Somnus						
Client					**Revision date**	29-Apr-22
Prepared by	Ronnie Paguia				**Revision No.**	1
Stakeholders					**Project refrence**	Project Somnus
Project teams	Design, Development, Project Management, Business				**Project Manager**	Ronnie Paguia
Issue Register						
ISSUE IDENTIFICATION				**ISSUE ASSESSMENT**	**ISSUE TREATMENT**	
Issue ID	**Identified By**	**Date Identified**	**Issue Description**	**Significance**	**Solution**	**Issue Status**
1	Project Team	29-April-2022	Faulty or inefficiency in existing computer system of the user	**High**	Offer a system package that includes the computer system	**Open**
2	Project Team	29-April-2022	Slow or frequently lagging of the existing internet subscription by the user	**Major**	Offer a system package that includes the computer system	**Open**
3	Project Team	29-April-2022	Missed milestones resulting in the inability to build prototype	**High**	Close monitoring and project team review	
4	Project team	29-April-2022	Lack of IoT Administration	**Medium**	Selection of the right platform provider	**Open**
5	Project team	29-April-2022	Skills shortages	**Medium**	Tie-ups with education and training institutions for internships	**Open**