CHAPTER 1
IDEA PROPOSAL

1.1 Background of the problem

Monitoring blood pressure is crucial for detecting and managing hypertension, which can lead to severe health complications such as heart attacks, strokes, and kidney failure. Despite the significance of blood pressure monitoring, studies have highlighted the growing concerns surrounding hypertension-related deaths, with mortality rates increasing by up to 13 percent. It has been recognized that merely monitoring blood pressure based on doctor's orders is insufficient, necessitating the need for individuals to monitor their blood pressure at home. [1]

Digital sphygmomanometers have gained popularity due to their ease of use and convenience, making them a practical choice for frequent blood pressure monitoring, particularly for outpatients [2]. However, existing digital sphygmomanometers lack the ability to provide users with blood pressure category results, which are essential for understanding the significance of their readings in the context of hypertension guidelines. As a result, users often resort to internet searches or consult healthcare professionals to interpret their systolic and diastolic measurements, leading to inefficiencies and increased healthcare burden.

Additionally, the reliance on manual written documentation for medical records in Indonesia poses challenges in terms of data management, potential loss, and limited accessibility [3]. The importance of accurate and timely medical databases is paramount for delivering optimal healthcare services, improving workflows for medical professionals, and facilitating research endeavors.

Recognizing the shortcomings and advantages of digital sphygmomanometers, this thesis focuses on addressing these limitations through the development of an enhanced digital sphygmomanometer. The proposed solution involves an ergonomic design integrated with Internet of Things (IoT) technology. By leveraging advancements in blood pressure reading systems and incorporating features from the latest BP monitor designs, this project aims to create a user-friendly and accurate BP monitoring tool that rivals the accuracy of desktop sphygmomanometers. This innovative device allows users to conveniently measure their blood pressure anywhere, providing immediate and reliable results. Furthermore, the incorporation of blood pressure category identification

enables users to promptly identify if their blood pressure is high, normal, or low, facilitating timely intervention and treatment for potential hypertension. To ensure efficient data collection and management, the device will be connected to a software application, enabling seamless transmission of data from users' mobile phones to a secure database for further analysis and review.

In summary, this thesis endeavours to address the deficiencies in current digital sphygmomanometers by developing an improved blood pressure monitoring tool. By enhancing accuracy, portability, and the ability to provide blood pressure category results, authors aim to empower individuals to take control of their blood pressure monitoring and contribute to more efficient and accessible healthcare practices.

1.2 Issue Support Information

The issue support information section outlines the rigorous testing conducted on the blood pressure measurement tool and mobile application. This includes validating the microprocessor, pressure sensor, and relay functionality. The Random Forest algorithm for blood pressure categorization was fine-tuned and optimized for 100% accuracy. User experience was prioritized through a friendly interface, secure authentication, and efficient data storage in the Firestore cloud database. These measures ensure a dependable and seamless blood pressure monitoring solution for users.

1.3 General Analysis

Both minor and major equipment issues are crucial in healthcare, thus each component of the equipment in discussion should be at its finest in terms of performance and reliability. The problem with digital sphygmomanometer can be derived into certain aspects:

1.3.1 Economic Aspect

Poor performance of the components and performance degradation may lead to unreliable or even incapable equipment in the long term. When an equipment is determined unable to perform its function, it might swell declared broken. Meaning the user need to repair and/or buy a new one. Sure enough, this is not ideal for institutions, burning budget on an equipment which should last for a lifetime. Also, having to monitor blood pressure by going to the hospital frequently might be an issue for the users because the financial burden associated with such endeavours poses considerable challenges for individuals, thereby exacerbating their predicament.

1.3.2 Manufacturability Aspect

In producing an electric device, the quality of each component should be one of the top priorities. Slightest amount of error or deficiency in the component may lead to possible harms to the manufacturer, such as worker's safety and company's prestige

1.3.3 User Convenience

In this research, authors prioritize user-centric features, such as an intuitive interface and seamless navigation, to provide a user-friendly experience. By integrating advanced technologies like IoT and mobile application connectivity, authors enable remote access to accurate blood pressure readings and efficient data management. Proposed tool enhancements empower individuals to make informed decisions about their health, simplifying the monitoring process.

1.3.4 Healthcare Service

The research on healthcare service introduces an innovative approach to remote patient monitoring with a user-friendly mobile application and non-invasive blood pressure measurement. Data security measures are well-implemented, and the study has the potential to improve healthcare accessibility and reduce in-person visits, especially benefiting those with mobility constraints. Overall, this research showcases an efficient and promising system for continuous remote monitoring in healthcare.

1.4 Needs to Be Met

Deduced from the problem and the authors' analysis of the aspects, the authors need to gene a system which is more convenient in monitoring blood pressure, self-sustaining device so it will not require the experts to recalibrate, more reliable in storing data and established device in the long term without affecting too much on the production cost.

1.5 Proposed System Solutions

Authors' proposed system solutions addressed the challenges in blood pressure monitoring by introducing a digital, portable, and user-friendly blood pressure measurement tool. This tool incorporated a MPX 5700AP pressure sensor for accurate readings and could be easily carried and used anywhere by the users. Additionally, the authors integrated the tool with a mobile application, allowing users to conveniently record and monitor their blood pressure readings. By integrating a machine learning model, users of our developed blood pressure measurement tool can instantly determine their blood pressure category, reducing the risk of mishandling.

This feature enhances user experience and provides immediate health insights. While fixed categories exist, our model's flexibility allows for future integration of additional parameters, such as age and BMI, enabling more accurate health predictions. This proposed solution streamlines blood pressure monitoring and empowers users with real-time health information.

1.5.1 Product Characteristics

1.5.1.1 Ergonomic Blood Pressure Monitor

A blood pressure monitoring system which is easy to operate and isn't aggressive to the individual being monitored. The idea is that it can be operated by anyone, even at home. So that a person can regularly check their blood pressure and have a good awareness of their health status.

The author's blood pressure monitor utilizes an air pressure sensor to read the pressure of the blood pressure cuff, which is then processed by a microcontroller to determine the systolic and diastolic pressure of the user. The design of the tool is idealized to the user's comfort and ease of use, author's BP tool operation method is similar to other BP monitors so that anyone can use the BP tool easily. The characteristic of this tool is that it can be used in any position the user deems comfortable.

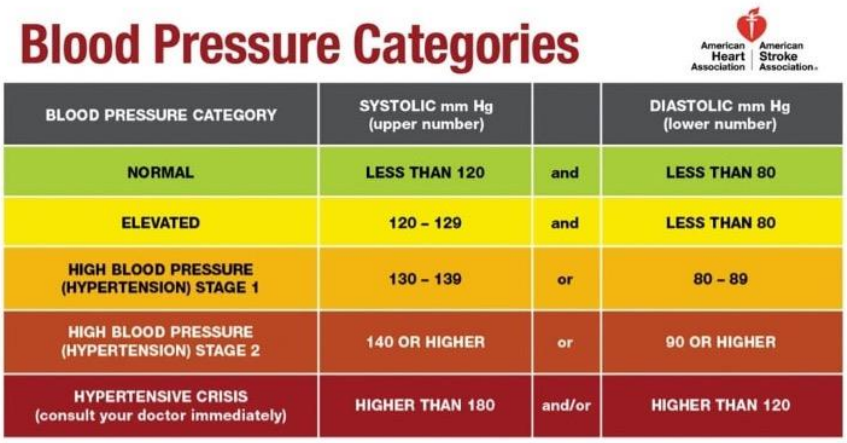
1.5.1.2 Blood Pressure Category Indicator

A reliable indicator system supported by the Random Forest Classifier is used by the blood pressure measuring device. This classifier is a machine learning algorithm that excels at handling classification tasks because of its adaptability and precision. Each decision tree in a Random Forest ensemble is trained using a portion of the data and features that are available.

Authors' indicator system can efficiently assess numerous aspects of blood pressure measurements and provide precise indicators about the relevant blood pressure category by using this advanced algorithm. The Random Forest Classifier excels at managing complicated datasets and can discern complex correlations between input features, enabling thorough categorization of blood pressure.

Our tool embodies unique attributes that redefine blood pressure monitoring. Central to its design is an embedded machine learning model, offering immediate blood pressure categorization. While established categories exist, our model ensures precise classification, enhancing user understanding and reducing measurement errors. This approach aligns with the American Health Association's standards, complementing their fixed categories.

Moreover, the model's adaptability allows future integration of parameters like age and BMI, expanding its predictive capabilities. This potential transformation positions our tool as a holistic health predictor, elevating its role beyond conventional monitoring. By combining accurate readings with simplified categorization, our product empowers users to proactively manage their well-being.



Blood Pressure Categories

American Heart Association | American Stroke Association

BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

Figure 1 Blood Pressure Categories by American Heart Association

Furthermore, the authors expanded the blood pressure categorization to encompass the low blood pressure category, which was not explicitly specified in the reference picture. This inclusion was based on consultations with a certified medical professional, who confirmed that systolic readings below 90 and diastolic readings below 60 are typically indicative of low blood pressure. By incorporating this additional category, the prediction system offers a comprehensive evaluation of blood pressure levels, encompassing both high and low blood pressure classifications.

The authors obtained a thorough dataset containing actual measurements from patients, including systole, diastole, and their respective blood pressure categories. The writers also provided the analysis of different parameters that could affect the model's performance. In addition, the writers also stated the comparison between the prediction model using the dataset obtained using the OMRON blood pressure measurement tool and the writers' own blood pressure measurement tool.

The categorization process aligned with the established criteria of the American Heart Association and was based on the provided reference picture. The utilization of this meticulously curated dataset enhanced the training process of the prediction system, ensuring the accuracy and relevance of the classification model. The inclusion of genuine patient data significantly boosts the tool's practicality and applicability in real-world scenarios.

1.5.1.3 Mobile Application

- Main Feature:

1. Live data report and tools status with Bluetooth connectivity
2. Check blood pressure monitoring history.
3. Database connectivity.

Software applications will be able to give user information about their tool state and real report whenever user do blood pressure monitoring, it will help user to see about their tool battery, basic information about tool condition (idle/error/working/scaling/calculating), systole/diastole of user, connectivity information with sphygmomanometer. The software application will be connected into cloud database, so database will detect users with certain unique code, and it can fetch and put their blood pressure monitoring data in database. This software application will help user to see their medical records and then this data can be given to a doctor for further research regarding user illness. Data stored will be secured by unique code that separate each account, so only user with identical unique id can access their own medical records. The writers' method of medical recording and monitoring can help prevent certain illness by tracing user or patient blood pressure history throughout their use of the tool.

1.5.2 Usage Scenarios

1.5.2.1 Ergonomic Blood Pressure Monitor

The method in operating author's blood pressure monitor is fundamentally the same as existing blood pressure monitor, where one's upper arm wrapped with inflatable cuff then wait a couple second for it to inflate and read the person's blood pressure as it deflates. The difference is that the person can use it however they like. They can use it while sitting, standing, laying down, whichever position suits them. The only requirement is that the air cuff is wrappoed on the upper arm.

1.5.2.2 Blood Pressure Category Indicator

The authors' blood pressure category indicator system offers a seamless user experience. After retrieving the systole and diastole data from the measurement tool, users can conveniently access their blood pressure records through the mobile application. The machine learning model, functioning independently from the application, provides a dedicated "model testing" section where users input their systole and diastole values. By leveraging the predictive capabilities of the model, users can obtain accurate blood pressure category predictions. The mobile application serves as a comprehensive platform for managing and reviewing blood pressure records, enabling users to track their health progress effectively. This integrated solution empowers individuals to proactively monitor their blood pressure and make informed decisions regarding their well-being.

1.5.2.3 Mobile Application

Data taken from the tool will also be stored in database, then users can review their history of blood pressure monitoring data in the apps. In the apps, users just need to make an account and it will automatically configure the code to link the app, database and tools. To link app and tools, user just need turn on their Bluetooth and pair it to the tools, after pairing success, tools will make sure that account connected is the right account that user desire.

1.6 Conclusion and Summary CD-1

In conclusion, this thesis addresses the limitations of current blood pressure monitoring systems by proposing an enhanced digital sphygmomanometer solution. The system integrates an ergonomic blood pressure measurement tool powered with microcontroller and air pressure sensor ensuring accurate readings and portability. A mobile application complements the tool, enabling users to conveniently record and monitor their blood pressure readings, while also providing access to historical data. The system incorporates a machine learning model for blood pressure category indicator based on systolic and diastolic inputs.

Through the proposed system, users can actively monitor their blood pressure, promptly identify their blood pressure category, and take necessary precautions or seek medical attention. The integrated solution enhances user convenience, reliability, and accessibility. By empowering individuals to track their blood pressure and make informed decisions about their health, the system promotes proactive healthcare practices. The adoption of advanced technologies, such as IoT and machine learning, showcases the potential for transformative advancements in blood pressure monitoring.

To conclude, this thesis presents a comprehensive solution that improves the accuracy, convenience, and effectiveness of blood pressure monitoring. It offers individuals the means to monitor their blood pressure anytime, anywhere, and empowers them to take control of their health. The proposed system has the potential to revolutionize healthcare practices and contribute to better health outcomes.