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The Systematic Design and Manufacturing of 'Mr. Money Manager'- An Advanced Money Management Device

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Abstract

Effective money management is a critical life skill that impacts individuals of all ages and professions. This research addresses the design and development of 'Mr. Money Manager' an advanced digital device that revolutionizes the concept of personal finance management. Through a comprehensive study of user needs and preferences, innovative features such as goal-setting capabilities, daily savings tracking, emergency fund management and biometric security measures are integrated into the device. The Quality Function Deployment (QFD) methodology, including the House of Quality (HOQ) matrix and functional decomposition, guided the systematic translation of customer requirements into technical specifications. Material selection and manufacturing process analysis are conducted to ensure optimal product quality and cost-effectiveness. A detailed cost analysis, including break-even point determination, is performed to assess financial viability. Additionally, lean manufacturing principles are implemented to identify and mitigate waste in the production and distribution processes. The development of 'Mr. Money Manager' represents a significant step towards empowering individuals to cultivate money-saving habits, achieve financial goals, and attain long-term financial stability through engaging and user-friendly experience.

Keywords

Money Management Devices, Digital Savings Devices, Goal Oriented Savings, Microcontroller, User Centric Product Design.

1. Introduction

In today's dynamic and fast-paced world, financial management is a critical aspect of every individual's life. The ability to effectively save, budget, and manage finances not only ensures financial security but also empowers individuals to achieve their long-term financial goals. Recognizing the significance of efficient financial management, our research endeavors to innovate solutions that facilitate prudent money management and savings practices. The motivation behind our research originates from the limitations and constraints associated with traditional piggy banks, which fail to meet the evolving needs and expectations of modern consumers. Traditional piggy banks lack the functionality to provide real-time insights into savings progress, restrict access to saved funds, and offer limited flexibility in goal setting and financial planning. Consequently, there exists a compelling need to develop a digital device that not only addresses these shortcomings but also enhances the overall user experience by incorporating advanced features and technologies.

The traditional piggy bank, while serving as a symbol of thriftiness and savings, falls short in meeting the diverse and dynamic needs of contemporary individuals. Key limitations of traditional piggy banks include their inability to provide real-time monitoring of savings progress, lack of security features, and limited functionality in goal setting

and financial planning. These constraints hinder users from effectively managing their finances and achieving their financial goals in a systematic and efficient manner.

Furthermore, with the arrival of digitalization and technological advancements, there exists an opportunity to use innovative solutions to revolutionize the concept of savings and financial management. By utilizing the power of digital technologies, such as fingerprint sensors and smart algorithms, it is possible to develop a digital device that not only overcomes the limitations of traditional piggy banks but also enhances the overall user experience by providing advanced features and functionalities. In light of these challenges and opportunities, our research aims to design and develop "Mr. Money Manager," a digital savings device that redefines the concept of financial management. Through the integration of technologies and user-centric design principles, "Mr. Money Manager" seeks to empower users to take control of their finances, set and achieve financial goals, and cultivate money saving habits for long-term financial stability and success.

1.1 Objectives

The research aims to develop an Enhanced Financial Management Device, known as "Mr. Money Manager," with the objective of revolutionizing personal finance management. In order to do this, a comprehensive study and analysis of user needs and preferences will be conducted to make sure that "Mr. Money Manager" satisfies the various financial management requirements of users from a range of demographic backgrounds. Innovative features will be incorporated into the device, such as goal-setting capabilities, emergency fund allocation, and advanced security measures using fingerprint and color sensors, to enhance user experience and effectiveness in financial planning.
Additionally, the research will focus on ensuring the user-friendly design and accessibility of "Mr. Money Manager" by adopting a user-centric approach, ensuring simplicity, ease of use, and accessibility for users of all ages and backgrounds. Furthermore, a comprehensive cost analysis will be conducted to evaluate the financial viability and potential return on investment of implementing "Mr. Money Manager". This analysis will assess the cost-effectiveness of development and production strategies, taking into account factors such as initial investment, operating costs, revenue generation and payback period. Finally, lean manufacturing principles will be implemented to identify, analyze, and mitigate the seven types of waste in the production and distribution process of "Mr. Money Manager," aiming to enhance productivity, reduce costs, improve quality, and increase overall effectiveness in bringing the device to market efficiently and sustainably.

2. Literature Review

Effectual money management techniques are very important for people of all ages and gender to spend money rationally. Nowadays it is more important because bills are paid via debit cards, E-Wallet, and Visa cards for which people can not realize the pitfalls of over-expenditures (Chawla, 2021.). It is obvious that students and unmarried earners are most likely to spend money in an objectless way. This kind of unplanned spending restrains people from achieving goals and harmonious distribution of daily expenses. As financial management is the key variable related to financial satisfaction, systematic and smart money spending behavior should be obtained (Bir and J.S 2014). Project provides a goal-directed approach to inculcating the saving behavior of children. The system prototype is based on the Waterfall SDLC methodology. Arduino Uno and Cytron ESP8266 Wi-Fi shield are the integrated central components of the project. This integrated central component is used to connect all the required IoT devices. The device is linked to an online database and mobile app which allows the parents to monitor the saving activities of their children. The coin recognition process is operated through an IR sensor and Arduino Uno. The value detected is calculated and sent to the cloud database and displayed on the LCD screen. The user can trace the saving activities through the mobile app. This device encourages children to learn self-control and stay persistent in achieving their goals. Some major drawbacks of the device are that it deals with coins only and cannot operate under internet interruption (Wee, B. L. and Eng, Y. W. 2021).

Smart piggy bank focuses on the savings behavior rather than the amount of money. The device tracks the saving behavior of the children and helps the parents to decide to transfer pocket money to the bank account of their children which is linked with the Smart piggy bank device. When a user inserts some coins, the action is notified to the application installed on their parent’s smartphone. The coin acceptor is built by a needle switch, and the needle switch is connected to the development board. The development board sends the acquired data to the smartphone application through Bluetooth. A bank account is connected with the application which collects the information and helps the parents decide to transfer pocket money to the bank account linked to the smart piggy bank. The device encourages children to build up saving habits. The bank gains potential customers, the children, as it offers the smart piggy bank

with a children's account when parents open an account. As an outcome, the bank can enrich its customer base by having child customers (Lee et al., 2017). Author presented a money management system to facilitate the collaboration of parents and children about money management. The author designed a device named 'Piggy Pennies' which provides a platform that integrates abilities to teach kids the concept of money itself and cultivate good, controlled spending habits to achieve their financial goals with parents' cooperation. There is an interactive Piggy Bank, which is a real-entity terminal for kids to handle real cash, for example, depositing, withdrawing, making purchasing plans, and taking care of chores. In addition, a mobile application is another terminal for parents to set up chores, send allowance, and monitor the role of their children (Tong, 2018).

This product is a combination of software and digitalized Piggy Bank made with Raspberry Pi 3 model to increase the saving behavior of children. In this system, the supervision of parents is done via a mobile app, and children are taught money management skills in three steps such as saving, spending, and sharing. As it is an IoT-based project, updated data is saved to an SQL database. But here a disadvantage is children are being notified with mobile apps about the savings on spending or updated data which is not a good practice (Palakvangsa-Na-Ayudhya et al., n.d.). Author presented a money detection device for people with visual disabilities. In daily life blind people depend on touching and hearing senses to recognize money which is hard for their economic life. The system of the device consists of RGB detection, data processing, and output device. Main components are LED RGB, LDR, DFRduino, DFplayer module and speaker. the device can detect money with an accuracy of 85.8% (Ilhami et al., 2019).

The paper is about an IoT based smart door unlock system where Arduino Nano has been used to control input and output. Among all the security ensuring processes, biometric locksets the most secure, as everyone has a unique fingerprint. In this device, the fingerprint will be scanned by a smartphone, which will produce a unique ID that will be sent to the Arduino Nano board. If the ID matches the ID previously set by the user, the lock will be opened with the help of a servo motor. Otherwise, the unlock position remains unchanged (Patil et al., 2020).

The study examines the relationship between mobile money usage and saving behavior, focusing on the propensity to save for health emergencies. Data collected from a survey conducted between May and June 2014 reveals that while there's no evident correlation between mobile money usage and saving for predictable expenses, such as routine costs, there's a notable increase in saving for health emergencies among mobile money users. Particularly, disadvantaged groups, including rural residents, females, less educated individuals, and those with irregular income, are more inclined to save for health emergencies through mobile money (Kim et al., 2008). This research provides valuable insights into the differential impact of mobile money on saving behavior, emphasizing its potential to promote financial resilience, especially among underserved populations. By highlighting the importance of safety, accessibility, and regional transferability, it underscores mobile money's role in fostering financial security and empowerment. (Ky et al., 2018).

3. Data Collection

A product is anything that can fulfill the requirements of a consumer. Customers buy based on product, brand, or service needs. Product manufacturing begins with consumer needs. Thus, the more the company meets the basics, the more they engage with customers and the better the product. Customers and producers must agree on requirements. The following section examines client needs, expectations, and suggestions for our product "Mr. Money Manager." Our product benefits people of all ages and professions, but we targeted these groups:

- Students
- Housewives
- Job holders

Area and Location:

A survey was conducted among representatives from a few companies and organizations as well as people from various professions. The following are some of them:

- Dettol Private Limited, Dhaka, Bangladesh
- Honest Trader's Sookh, Dhaka, Bangladesh
- Career Visa Point, Dhaka, Bangladesh
- Pioneer Dental Point, Dhaka, Bangladesh
- Military Institute of Science and Technology, Dhaka, Bangladesh
- Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

- Bangladesh University of Textile Engineering, Dhaka, Bangladesh
- Notre Dame College, Dhaka Bangladesh
- Shahjalal University of Science and Technology, Sylhet, Bangladesh

Table 1. Outcome of Survey

Question	Options	Percentage of votes (%)
Which one you prefer for saving money?	Traditional way (Piggy Bank, Locker)	52
	Digital Way (Mobile Banking, Bank Deposit)	48
Which security system do you prefer?	Manual Lock	2
	Pin or Password	35.3
	Finger-Print	48
	Face-Recognition	14.7
How do you want to operate the device?	Control Panel (button)	43.1
	External Remote Control	6.9
	Android Control	50
What type of currency would you like to save?	Coins	1
	Notes	49
	Both	50
Do you want a function that will remind you to reach your goal amount?	Yes	80.4
	No	12.7
	May be	6.9
Do you want to limit your daily withdrawal amount?	Yes	54.9
	No	27.5
	May be	17.6
How frequently do you want to open the daily usage section?	Once a day	32.4
	Twice a day	40.2
	More than twice	27.5
Material suggestion-	Wood	4.9
	Plastic	5.9
	Metal	89.2
How do you want this device to notify you about deposits and withdrawals?	e-Mail	34.3
	Message	21.6
	Both	40.2
	None	3.9
Which power supply do you prefer?	Disposable Batteries	8.8
	Rechargeable Batteries	49
	Direct Electricity	42.2
How much are you willing to pay for our product?	Below 90 USD	52
	Between 90 - 135 USD	18.6
	Between 135 - 180 USD	6.9
	Between 180 - 225 USD	5.9
	Over 225 USD	16.7
Are you interested in purchasing when we launch our product?	Yes	46.1
	No	6.9
	May be	47.1

Medium of Survey:

- Online survey through Google forms (Table 1)
- Face to face interview
- Interview over phone

Valuable ideas for the design and development of the Mr. Money Manager are derived from the customer survey. While nearly every respondent agreed on the importance of money management, preferences split when it came to saving methods: half preferred traditional methods, while the other half leaned towards digital options. Security was a priority, with fingerprint systems being the clear favorite. Interestingly, customers desired the ability to save both coins and bills. Although a majority initially favored an Android-controlled system, the potential cost increase led us to prioritize a control panel system desired by 43.6%. The utmost importance was placed on durability, with metal being the favored body structure material. Customers also expressed a strong preference for a rechargeable battery power system. Functionality played a key role as well, with users wanting reminders to save and notifications for deposits and withdrawals via both message and email. The price point proved crucial, with most customers unwilling to spend more than $100. Encouragingly, a significant portion (46.1%) expressed interest in purchasing the Mr. Money Manager, with an additional 47.1% indicating a potential purchase, suggesting a strong market response.

4. Methodology

The methodology employed in this study employs a systematic approach to product development known as Quality Function Deployment (QFD). Beginning with the Voice of the Customer (VoC), QFD translates customer needs and expectations into technical requirements, facilitating informed decision-making throughout the product development process. Key to this methodology is the House of Quality (HOQ), a matrix that correlates customer needs with the necessary activities to meet them, providing a roadmap for product planning. Functional Decomposition further dissects the overall function of a device, system, or process into its essential components, enhancing understanding and facilitating streamlined processes. The Black Box Model of Functional Decomposition explains the relationship between a system's inputs and outputs, crucial for evaluating system behavior. Component Hierarchy classification organizes essential product components into distinct divisions, offering a structural view of the material system. Finally, the Cluster Function Structure visually represents the interconnected processes within a product, aiding in workflow verification and error detection.

4.1 House of Quality

Relations hip	Symbol	Weight
strong	●	9
moderate	◎	3
weak	○	1

Corelation	
strongly positive	++
positive	+
none	
negative	-
strongly negative	- -

Customer Requirements	Customer ratings	Material type	Rechargeable battery	Security system	Notification	Control System	Overall Cost	Out look	Sensors	Processing unit	Our product	Cashier Personalized Digital Piggy Bank	Money Box Machine Piggy Bank
Reasonable price	5	●	◎	●			●	○	○	○	3	5	5
Light weight	4	●	◎							○	3	4	3
Rechargeable power source	4		●				◎	○		○	4	4	5
User friendly	4			●	◎	●			●	◎	4	4	4
safety	4	●		●					●		5	4	3
Automation	2				◎	◎	●		●	●	5	3	3
Saving behavior	5			○	●	◎			◎		4	2	2
Aesthetic	1	◎					○	●			4	2	3
Durability	3	●					◎		◎		4	3	2
Importance ratings		147	63	122	63	57	85	18	119	43			
% of Rating		20	8.8	17	8.8	8	12	2.5	17	6			

Technical Assesment

Figure 1. House of Quality

Figure 1 illustrates the House of Quality (HOQ) for the product under development. Within this diagram, the relationships between various customer requirements and product specifications are identified. Through the aggregation of customer ratings for different requirements, a prioritized list is generated, determining which technical specifications should receive greater emphasis. The relationships between specific customer requirements (such as reasonable price, light weight, user-friendly features, safety, automation, saving behavior, aesthetic appeal, durability) and corresponding technical requirements (such as material type, rechargeable battery, security system, processing unit, sensors, notification system, control system) are outlined using different rating symbols. The top triangle highlights the relationships between different technical terms, categorizing them based on their relationship status (positive, negative, strong positive, strong negative). These relationships encompass various aspects of product development, including cost implications, functionality, and performance (Table 2).

Table 2. Priority list of different requirements (Descending)

Order	Requirements	Importance Rating	Percentage of Rating
1	Material type	147	20
2	Security system	122	17
3	Sensors	119	17
4	Overall Cost	85	12
5	Rechargeable battery	63	8.8
6	Notification	63	8.8
7	Control System	57	8
8	Processing unit	43	6
9	Outlook	18	2.5

The following Table (2) presents a priority list of different requirements for the product under development, arranged in descending order of importance rating. Each requirement is assigned an importance rating, representing its relative significance in the development process. Additionally, the percentage of rating is provided, indicating the proportion of the total importance rating attributed to each requirement.

4.2 Functional Decomposition

Functional decomposition, a term commonly employed by engineers, refers to the process of dissecting the overall function of a device, system, or process into its constituent components. Through meticulous analysis of project data and collaborative team discussions, this approach aims to streamline processes and enhance cost-effectiveness. By breaking down complex systems into manageable components, functional decomposition facilitates a deeper understanding of how processes operate and how individual components interact with one another. This method focuses on identifying the fundamental task that a device or process must accomplish, delineating essential sub-functions crucial to its success, and hierarchically organizing subsequent tiers of sub-functions.

The black box model (Figure 2) demonstrates how the Mr. Money Manager interacts with its users, internal operations, and processing system. It focuses on the device's primary purpose of managing personal funds, which includes budgeting, cost monitoring, transaction processing, security, and perhaps financial control. There are two primary input categories: Energy Flow (electrical power to operate various sections), Information Flow (coded instructions, user information, biometric identification, and money data such as amount to deposit or withdraw and perhaps account information). As an output, electrical energy is turned into mechanical energy to provide necessary motion to different mechanisms and components. Output Information Flow comprises transaction confirmations, account updates presented on the screen, and data delivered to other platforms for user convenience. Material flow is completely prohibited since the gadget lacks physical outputs or conversion of the property of any input.

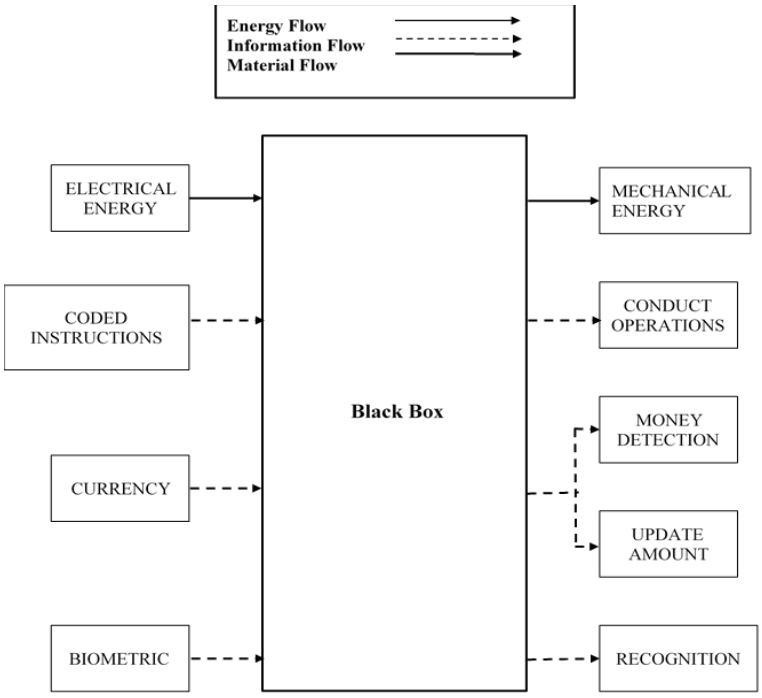

Figure 2. Black Box Model of Mr. Money Management

The component hierarchy (Figure 3) provides a fundamental overview of how the device Mr. Money Manager distributes its operations across its sub-sections. At the top of the structure is the Mr. Money Manager, which represents the whole system. Further analysis demonstrates sub-sections in charge of various functions.

- **Main Body:** This refers to the physical structure of the device, including the outer casing and a compartment door for user interaction.

- **Security System:** This sub-section presumably safeguards the device and user information. It might include components like locks for physical security, biometric scanners for user identification, and a microcontroller, the brain of this sub-system, that manages these security measures.

- **Data Processing System:** This section likely handles the core functionalities of the device. It might contain a microcontroller as the central processing unit, along with a sensor that reads information from inserted currency (like denomination and quantity), and a notification unit that could consist of a display screen and speaker for user interaction.

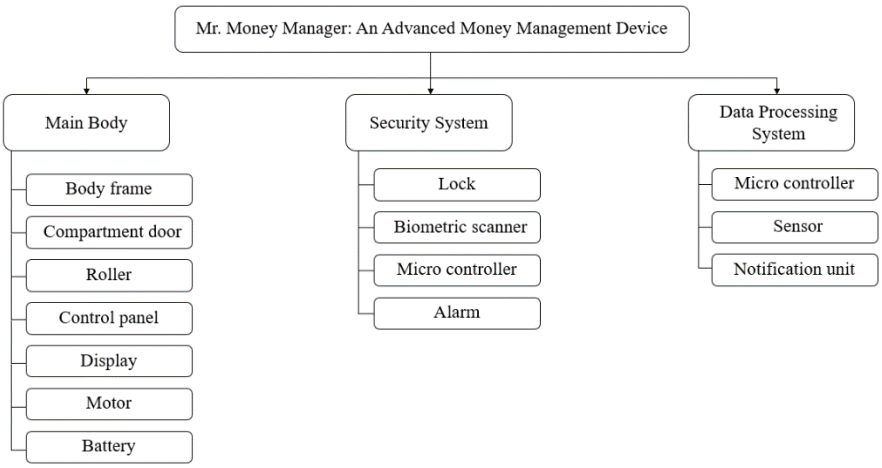

Figure 3. Component Hierarchy Diagram of Mr. Money Manager

5. Design Analysis

The device incorporates several key components essential for its functionality. Figure 4.1 depicts the rollers, which guides the money towards the internal chamber while ensuring proper detection by the color sensor. Figure 4.2 illustrates the locker door, a panel made of metal designed to cover and secure the money stored within the locker. Equipped with an automatic solenoid lock for enhanced security, the locker door ensures the safe storage of money. Additionally, Figure 4.3 showcases the inner gates, metal panels with rotational motion used to open or close specific chambers internally. When money is inserted, one of the three internal gates opens to guide the money to the desired section, ensuring accurate sorting and organization. Alongside these components, screws (Figure 4.4) play a crucial role in fastening various parts of the device. Furthermore, the device features additional components for user interaction and data processing. Figure 4.5 highlights the side door, covering the working chamber behind the input section, where components like the color sensor and display are housed. The solenoid lock (Figure 4.6) provides biometric security, disengaging upon successful user authentication. Figure 4.7 showcases the color sensor, detecting and distinguishing different colors of currency notes for accurate processing. The control keypad (Figure 4.9) allows users to input commands, such as password insertion or section selection. Additionally, the fingerprint sensor (figure 4.10) captures and analyzes fingerprints for user authentication. Controlled by the Arduino Mega microcontroller (Figure 4.11), these components work together to ensure the device's functionality, providing users with a secure and efficient financial management solution. The servo motor (Figure 4.12) enables precise control of the internal gates' positions, ensuring accurate guidance of money into the desired sections.

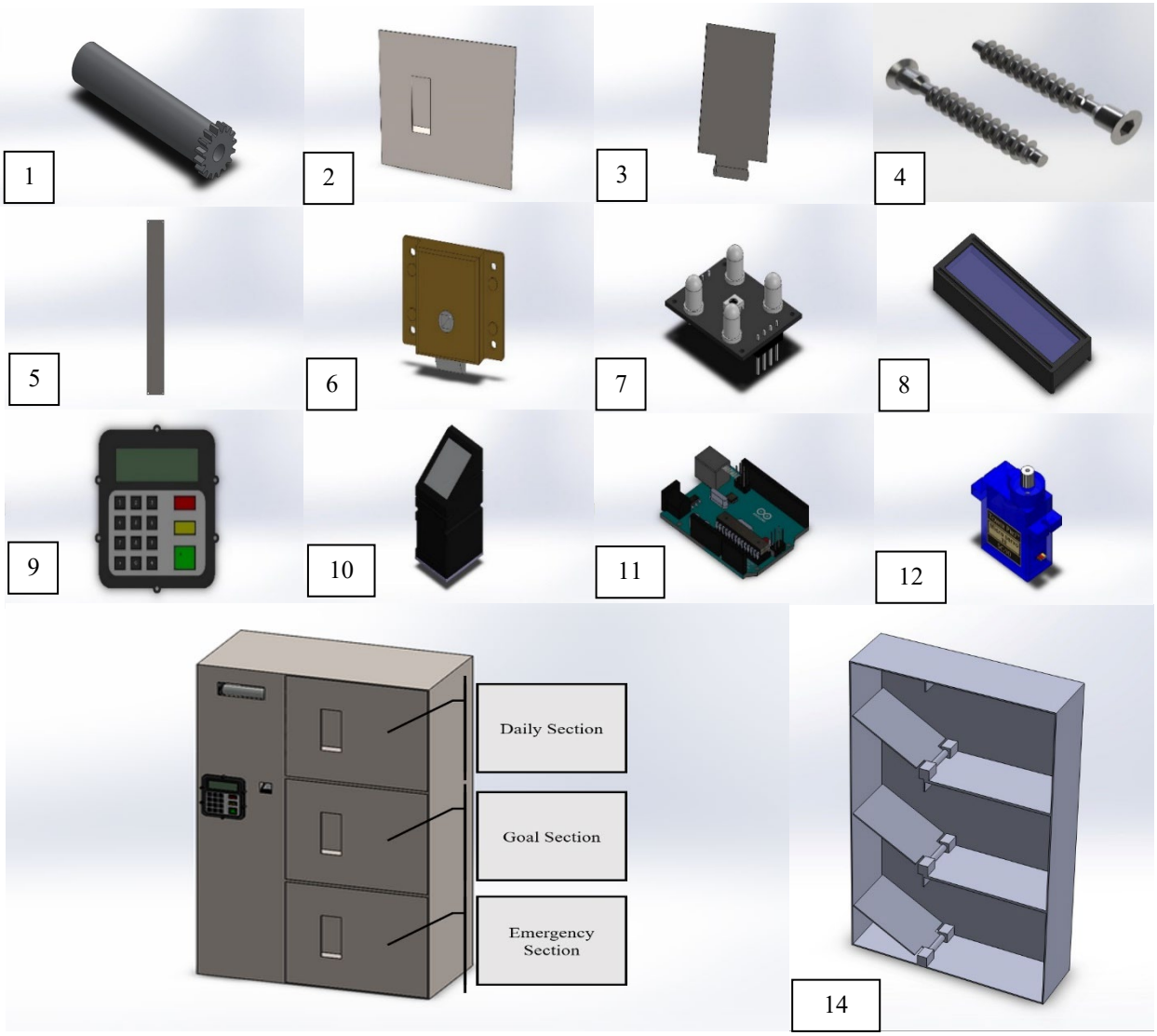

Figure 4. Components and Final Assembly of Mr. Money Manager

Figure 4.13 depicts the final assembly of the device, showcasing how all the individual components come together to form a cohesive unit. The Goal Section of Mr. Money Manager is designed for goal-oriented saving. Users can set a target amount for their savings and begin saving in this section. However, the Goal Section cannot be accessed until the target amount is met, ensuring disciplined saving habits. The Daily Usage Section serves as a tool for daily money management. Users can access this section twice a day, limiting unnecessary expenditures. Additionally, all deposits and withdrawals made in this section are continuously tracked, providing users with insight into their daily financial activities. In times of emergency the users can access the Emergency Section instantly whenever faced with unexpected situations, providing them with peace of mind and financial security during challenging times. In contrast, Figure 4.14 offers a cross-sectional view of the device, revealing its internal structure and mechanism.

6. Results and Discussion

6.1 Material and Manufacturing Process Selection by Weighted Average Method

Material and Manufacturing process selection plays a pivotal role in determining how materials are transformed into the final product. The decision regarding the most suitable manufacturing method involves a delicate balance of factors such as material properties, design specifications, labor requirements, and equipment capabilities. With the Weighted Average Method, these diverse factors can be systematically evaluated to identify the optimal manufacturing process. By assigning weights to each criterion based on its relative importance, the Weighted Average Method facilitates a comprehensive assessment that considers multiple variables simultaneously. This method can be used to make informed decisions that align with product requirements and production constraints. As manufacturing processes vary in complexity and efficiency, the Weighted Average Method provides a structured approach to navigate these considerations and arrive at an optimal solution. Through careful evaluation and analysis, manufacturers can select

the most suitable production technique to achieve their desired outcomes efficiently and effectively (Table 3- Table 12).

6.1.1 Material Selection for Mr. Money Manager (Manufacturing Parts)

Table 3. Determination of Relative Importance of Goals Using Digital Logic Method

Selection Criteria	Number of Positive Decisions, N = n(n-1)/2 = 7(7-1)/2 = 21																					Positive Decisions	Relative Emphasis Co-efficient (α)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
Cost	1	1	0	0	0	1																3	0.143
Material Density	0						0	1	1	1	0											3	0.143
Availability		0					1					0	0	1	1							3	0.143
Machinability			1					0				1				0	0	0				2	0.095
Anti-corrosive				1					0				1			1			0	1		4	0.19
Hardness					1					0				0			1		1		1	4	0.19
Lustrous						0					1				0			1		0	0	2	0.095
Total number of positive decisions																						21	Σ α = 1

Table 4. Numerical value for Cost, Availability, Machinability, Anti-corrosive and Lustrous

Evaluation	**Rating**
Very High	5
High	4
Medium	3
Low	2
Very Low	1

Table 5. Assigned value for Cost, Availability, Machinability, Anti-corrosive and Lustrous

Selection Criteria	**Aluminum**	**Mild Steel**
Cost	5	3
Availability	3	4
Machinability	4	2
Anti-corrosive	4	4
Lustrous	2	3

Formula Used:
For Availability, Machinability, Anti-corrosive, Hardness and Lustrous:
Scaled property, β= (Numerical value of individual property / Maximum value in list) ×100%
For Cost and Material Density: Scaled property,
β= (Minimum value in the list / Numerical value of individual property) ×100%

Table 6. Calculation of the performance index

Selection Criteria	Weighting factor (α)	Aluminum		Mild Steel	
		Scaled Property (β)	Weighted Score (αβ)	Scaled Property (β)	Weighted Score (αβ)
Cost	0.143	60	8.58	100	14.3
Material Density	0.143	100	14.3	34.52	4.94
Availability	0.143	75	10.73	100	14.3
Machinability	0.095	100	9.5	50	4.75
Anti-corrosive	0.19	100	19	100	19
Hardness	0.19	52.78	10.03	100	19
Lustrous	0.095	67.67	6.43	100	9.5
Material Performance Index (γ)	Σαβ		78.57		85.79

Material performance index of Mild steel (86) is greater than that of Aluminum (78.78). So, we have selected Stainless steel as material for the parts that we will manufacture.

6.1.2 Manufacturing Process Selection for Sheet Metal Cutting

Table 7. Determination of Relative Importance of Goals Using Digital Logic Method

Selection Criteria	Number of Positive Decisions, N = n(n-1)/2 = 7(7-1)/2 = 21																				Positive Decisions	Relative Emphasis Co-efficient (α)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
Cost	1	1	0	0	0	1																3	0.143
Material Density	0						0	1	1	1	0											3	0.143
Availability		0					1					0	0	1	1							3	0.143
Machinability			1					0				1				0	0	0				2	0.095
Anti-corrosive				1					0				1			1			0	1		4	0.19
Hardness					1					0				0			1		1		1	4	0.19
Lustrous						0					1				0			1		0	0	2	0.095
Total number of positive decisions																						21	Σ α = 1

Table 8. Numerical Values (Rating)

Evaluation	Rating
Very High	5
High	4
Medium	3
Low	2
Very Low	1

Table 9. Assigned Rating

Selection Criteria	**Shearing**	**Layer cutting**
Cost	3	5
Dimensional Accuracy	4	5
Availability	5	3
Surface Finish	3	4
Ease of Operation	4	5
Power Requirement	3	5
Material Wastage	3	2

Table 10. Calculation of Performance Index

Selection Criteria	Weighting factor (α)	Shearing		Laser Cutting	
		Scaled Property (β)	Weighted Score (αβ)	Scaled Property (β)	Weighted Score (αβ)
Cost	0.143	100	14.3	60	8.58
Dimensional accuracy	0.095	80	7.6	100	9.5
Availability	0.238	100	23.8	60	14.28
Surface finish	0.191	75	14.33	100	19.1
Ease of operation	0.143	80	11.44	100	14.3
Power requirement	0.095	100	9.5	60	5.7
Material wastage	0.095	66.67	6.33	100	9.5
Material Performance Index (γ)	Σαβ		87.3		80.96

Material performance index is greater for Shearing (87.3). So, we have selected the Shearing process for sheet metal cutting operation.

Formula Used:
1. For selection criteria: Dimensional Accuracy, Availability, Surface Finish, Ease of Operation, Durability:
Scaled Property, β = (Numerical Property ÷ Maximum Value of List) × 100
2. For selection criteria: Cost, Power Requirement, Material Wastage, Heat Affected Zone:
Scaled Property, β = (Minimum Value of List ÷ Numerical Value of Property) × 100

Table 11. Summary of Manufacturing Process Analysis

Process	Parts	Available Manufacturing Process	Selected Process
Sheet Metal Cutting	Body-Frame Door Sliding Plate	Shearing Laser Cutting	Shearing
Joining (Permanent)	Permanent Body Parts	TIG Welding Resistance Spot Welding	TIG Welding
Joining (Temporary)	Temporary Body Parts	Screw Tapping Nut-Bolt	Screw Tapping
Finishing	Body-Frame Door Sliding Plate	Precision Grinding Non-Precision Grinding (Polishing)	Non-Precision Grinding (Polishing)
Coloring	Body-Frame Door	Color Spraying Chemical Coloring	Color Spraying

6.2 Cost Analysis

Cost analysis is the process of identifying all expenses associated with a product or service to figure out the direct and indirect costs, as well as calculating the final price. Estimating expenses in early product development can be difficult due to uncertainty. The analysis tries to increase product value while maintaining or lowering costs. Market conditions, competitive pricing, long-term planning, manufacturing, administrative, and marketing expenses, labor costs, and feasibility are all factors to examine. Cost analysis aids in assessing project feasibility, revenue targets, and the Break Even Point, all of which require good management throughout.

Table 12. List of All Expenses

Type of Cost	Area of Expenditure	Cost ($)
Machine & Associated Costs	Shearing Machine	3171
	Tig Welding Machine	152
	Non-Precision Grinding Machine	4162
	Measuring Equipment	145
Cost of Furniture, Computer & Other Accessories	Total furniture & accessories cost	711
	Computer Cost	475
Administrative and Selling Cost (per year)		25,560
Fixed Manufacturing Overhead Cost (Per year)		23,760
Total Fixed Cost		**58,136**
Costs of Raw Material (Per year,500 units)	Mild Steel Sheet	8,000
	Paint	6,000
Manufacturing Cost of Different Operations (Per year)	Measuring and Cutting	1,440
	Welding	1,200
	Grinding and Polishing Operation	480
	Assembly and Computer Operator	2,400
	Painting	600
	Packaging and Sorting	1,200
Variable Manufacturing Overhead (Per year)		3,000
Parts Purchasing Cost (Per year,500 Units)		53,700
Total Variable Cost (Per year,500 Units)		**78,020**

6.2.1 Break Even Point Analysis

Total amount of Fixed Cost =$ 58,136 Per year
Total Variable Cost per year = $78,020
Total variable cost per unit production = 78,020 ÷ 500 = $156
Selling Price per unit = 156 + 30% of 156 (we are expecting 30% profit on sale)
= $202
Profit per unit =$ 46
Break-Even point (units) =Total fixed cost /(Selling price per unit -Total variable costs per unit)
So, Break-Even units = 58,136 ÷ (202 - 156) = 1,263.82 ~ 1,264 units.
To produce and sell these units as well as meet the Break-Even we will need around 2 years 5 months' time which is the Payback period (Figure 5).

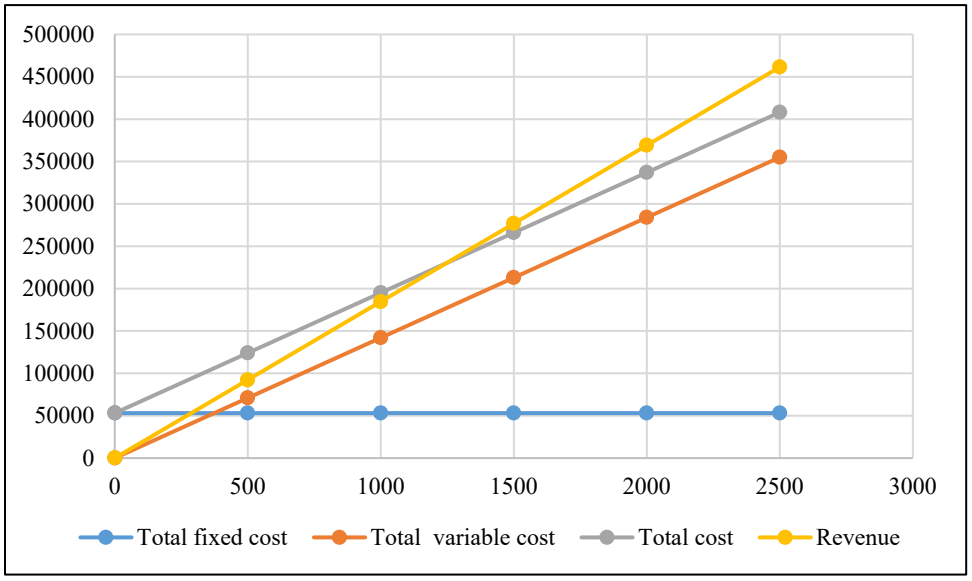

Figure 5. Breakeven Analysis of Mr. Money Manager

6.3 Reduction of Seven Wastes

Lean Manufacturing, with its focus on minimizing waste and maximizing value, identifies seven key areas of waste that can hinder production efficiency. These wastes include transport, inventory, overproduction, motion, defects, waiting, and over-processing. Addressing these wastes in the production of "Mr. Money Manager" is crucial to optimize resource utilization, minimize costs, and enhance overall product quality.

Transport Waste: In the production of "Mr. Money Manager," transport waste is evident in the frequent movement of materials and components between assembly locations and suppliers. This results in increased lead times, inefficiencies, and added costs. To mitigate transport waste, we propose optimizing material flows by maintaining direct processes with minimal delays. Proactive supplier selection and establishing localized inventories near suppliers will reduce transportation distances and lead times, ultimately streamlining the production process.

Inventory Waste: In the production of "Mr. Money Manager," inventory waste arises from large order quantities due to distant suppliers and prolonged inventory holding times, resulting in increased expenses and potential material degradation. To combat inventory waste, we advocate for establishing localized inventories near suppliers to reduce lead times and order quantities. Additionally, implementing Kanban systems and Just-In-Time (JIT) delivery strategies will promote inventory optimization and ensure a continuous flow of materials.

Overproduction Waste: In the production of "Mr. Money Manager," overproduction may result from difficulties in monitoring production demand and challenges in meeting fluctuating customer needs. To address overproduction, collaboration with Lean advocates and the implementation of JIT delivery strategies are proposed. By aligning

production with customer demand, minimizing batch sizes, and establishing stable schedules, overproduction can be significantly reduced.

Motion Waste: In the production of "Mr. Money Manager," motion waste is observed in inefficient workstation layouts and disorganized workspaces, leading to increased idle activity and decreased productivity. To minimize motion waste, we recommend redesigning production facilities to optimize workflow and reduce unnecessary movement. Implementation of the 5S technique, focusing on sorting, setting in order, shining, standardizing, and sustaining, will enhance workspace organization and streamline operations.

Defects Waste: In the production of "Mr. Money Manager," defects may arise from substandard welding or malfunctioning electrical components, leading to quality issues and increased costs. To mitigate defects waste, investment in precision welding equipment and the establishment of standard operating procedures (SOP) are recommended. Additionally, upgrading sensors and enhancing training programs will improve product quality and reduce defect occurrences.

Waiting Waste: In the production of "Mr. Money Manager," waiting waste may result from supply delays, prolonged manufacturing lead times, and machine downtime. Effective management of lead times, establishment of localized manufacturing facilities, and proactive machine maintenance scheduling are proposed solutions to mitigate waiting waste. By ensuring a continuous flow of materials and minimizing downtime, waiting waste can be significantly reduced.

Over-processing Waste: In the production of "Mr. Money Manager," over-processing may occur due to the inclusion of redundant security features, such as redundant authentication methods. To address over-processing waste, customization of product features based on customer preferences and requirements is recommended. By offering customizable security features and eliminating redundant processes, over-processing waste can be minimized while optimizing resource utilization.

7. Conclusion and Future Recommendations

The development of "Mr. Money Manager" represents a significant step towards revolutionizing personal finance management. By leveraging innovative technologies and user-centric design principles, this device aims to empower individuals to take control of their finances, cultivate money-saving habits, and achieve long-term financial stability. Through a comprehensive analysis of user needs and preferences, coupled with rigorous design and manufacturing processes, "Mr. Money Manager" has been meticulously crafted to provide an engaging and user-friendly experience. The integration of advanced features, such as goal-setting capabilities, emergency fund allocation, and biometric security measures, demonstrates a commitment to addressing the limitations of traditional piggy banks and meeting the evolving needs of modern consumers. The cost analysis and implementation of lean manufacturing principles have ensured the financial viability and cost-effectiveness of "Mr. Money Manager," paving the way for its successful commercialization and widespread adoption. While the development of "Mr. Money Manager" has addressed numerous challenges in personal finance management, there remains room for further innovation and improvement. First, a redesign focusing on smaller dimensions and lighter weight would make the device more portable and easier to store, benefiting users with limited space or those who value mobility. Second, implementing high-performance color sensor equipment controlled by a Raspberry Pi could significantly improve currency recognition accuracy and efficiency, leading to a smoother user experience. Third, incorporating a roller mechanism for money input would streamline the deposit process, minimizing errors and improving usability. Finally, developing a dedicated mobile application and integrating it with "Mr. Money Manager" would create a more comprehensive and interconnected user experience. The app could offer features like real-time monitoring, budgeting tools, and personalized financial insights, further boosting the device's functionality and user engagement. By embracing these recommendations and continuously seeking opportunities for improvement, "Mr. Money Manager" can evolve into a truly innovative and indispensable tool for personal finance management, empowering individuals to achieve their financial goals.

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