

# Audio Control System for Classrooms, Museums and Airports.

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## Abstract

The motivation of this project is to rectify the audibility problems in Classrooms and Conference Halls by using a Sound Control system which will ensure that every person/Student in classroom will hear properly to what Professor/Lecturer is saying. In this system, we will transmit Professor's voice on a particular FM frequency using FM Transmitters. Students can listen to Professor using his Smartphone or any kind of FM Receiver. Furthermore, this system can also be used in Museums, Art galleries, Airport Terminals etc. to guide visitors/Travelers by transmitting crucial data about that place on a particular FM Frequency. This will avoid confusion between travelers at the airport terminals about directions and gate numbers and it will also help tourists at museums by providing them information about certain Art work.

## ACKNOWLEDGMENTS

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## **1.1 Business Objective:**

“The Problem with Voice? We are here to solve!”

In our day to day life everyone must have come across events where one had to attend a seminar or a presentation or a lecture. The most important thing for these events to be successful is information delivery channel used. As we must agree, voice is most widely used channel for transfer of information in lecture halls or conference rooms. We miss many vital details if the audio level used for delivery is not appropriate to sense and interpret. It could be because of a bad sitting spot or two different speakers with different voice tones talking in turns where volume adjustment is necessary or might even be the variations in speaker's voice level.

If there could be an ambient light sensor used to adjust light intensity in a room, why can't there be a sound detector used to adjust speaker volume? But there isn't to our surprise. In today's teaching world, efficiency of students is tied in closely to students' ability to properly hear the instructors. Teachers and students should be able to connect with each other in real-time to develop the insights required to foster learning.

In classrooms, instructors need to do a lot of things along with delivering lectures. Setting up projector, explain diagrams, dictate material, browse through notes etc. This can cause variations in lecturer voice level reaching the students, sometimes making it difficult for students to hear it clearly. We often come across situations where in students fail to properly receive the instructions or instructors fail to understand whether the used voice level is sufficient to be audible across entire classroom.

## 1.2 Product Description:

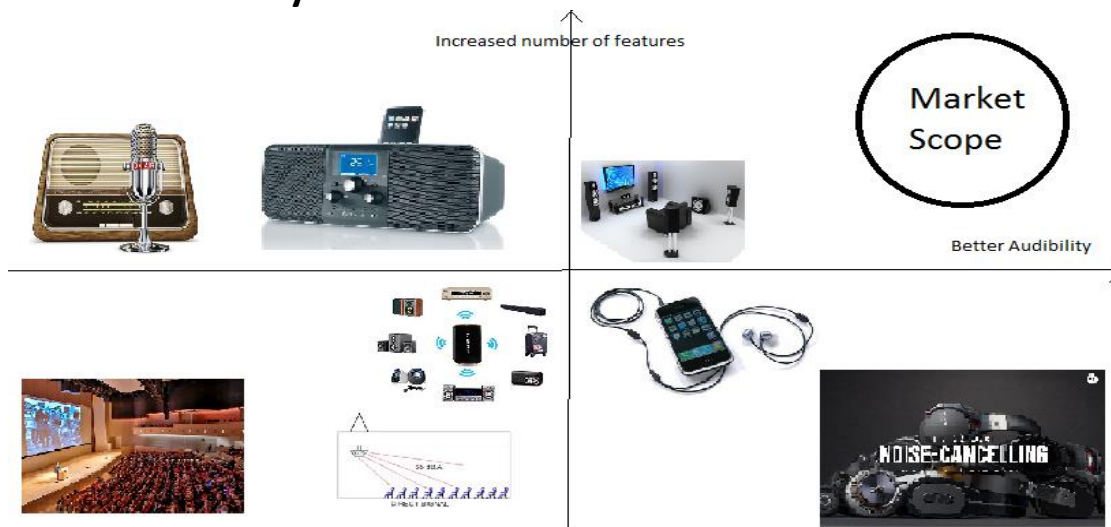
Our product provides a very efficient solution by giving an almost zero lag Frequency Modulation transmission system which can be used in classrooms, Libraries, Museums, Aquariums etc. where you need the functionality of sorting different sounds and playing the sound you desire. Our solution involves recording all sound sources with a mic and transmitting each signal to a different frequency, which can be accessed by the user.

So, this provides a clear and loud audio signal to the user. And he/she gets the entire freedom to choose between different frequency to listen to what he/she deserves.

Based on a classroom standpoint, our system provides a unique solution by giving the listener the best way to listen a lecturer. All the professor must do is to speak through a small mic, as simple as that. The students can just open their mobile phone, use the FM radio app, plug in headphones, and set the frequency. The mobile also provides freedom for the listener to increase the volume or reduce it based on needs.

Airport and Museums provide a different scenario. Can you imagine getting a personal announcement just for you in a public place like airport or museum? Yes, our system does that as well. In an airport scenario suppose you will never miss an announcement. All you should do is use a headphone and connect to your phone and tune in to a channel which just gives details about your flight. The app will run in the background and pop up important announcements. So, you can enjoy your music in your noise cancelling headset and not worry about missing an announcement. In a museum, you can just walk near any display, which will have a frequency range and use your phone to receive information about the display.

### 1.3 Market analysis:



Existing market has 2 ways of audio input to a speaker- Aux cables, Bluetooth. While speakers are widely used in communication starting from home theatres, classrooms, Theaters and auditoriums etc. But these conventional system is constrained to provide quality sound to only limited space. If the quality sound needs to be equally provided in a complete space, more number of speakers are to be placed and the rooms must be acoustically designed. Even with increased number of speakers, there are chances that the volume form mic can go below the ambient sound. To tackle this problem, an auto volume adjust system must be incorporated. This system is currently existing in modern TV and cars where there is a controlled space.

Noise cancelling devices have a different market scope and is not included yet in classroom or live sound environment. Hence there is a huge market scope in the space where people want better audibility with noise cancellation without spending too much. Our product will redefine the communication device systems.

### **1.3.1 Market estimation:**

United States was considered to be our primary market. There are 4140 schools and universities in US. About 35000 museums and 16000 airports. We are assuming at least 3% of these institutions would be interested in our product. This accounts to 1650 market size. We are taking conservative estimate of 6% of market since we are the only contenders for this market space. Since our product is a new solution in the market, we have considered that our sales will increase by rate of 12% for next three years.



## **1.4 Capital and Personal Resources:**

Our manufacturing facility will actually be just assembly facility. The major share of investment will be the salaries of employees and inventory space.

We are asking for an investment of \$210,000. This amount will cover startup costs of facilities, workstations, and operation as well as minimal salaries for our employees during year zero when we are assuming there will not be any selling. Once vendor development is done, we will be ready with capability to deliver the product at the end of first quarter of year. We will purchase and stock the components needed for assembly of final product. The exact distribution of this investment can be seen in our pro forma income and profit projections in the Financial Data section of this report. Recent studies made by MoneyWatch an online investment support site shows that state of Wyoming have the lowest taxes on industrial facilities. Since our facility do not heavily depend on manufacturing infrastructure availability and does not need a specific specialty set of work skills we are going ahead with a location which will prove cheapest. We will acquire a studio space in Cheyenne, Wyoming which will serve as the main office, inventory and assembly space. Another small portion of the investment would go towards purchasing all the necessary tools, workstations, office supplies, and any other equipment that is needed for our business.

## 2.1 Capital Equipment and Supply list

### Fixed Cost

<u>Initial Development</u>		<b>Fixed Operating Cost (per yr.)</b>	
Engineering	\$100	<b>Employees</b>	\$200,000
Industrial Design	\$100	Marketing and sales	\$2,000
Marketing	\$300	Cleaning and maintenance	\$1,000
<u>Manufacturing Process</u>	\$500	Salary for Personnel	\$2,000
<u>Development</u>		<b>Administrative</b>	
Equipment	\$200	Rent	\$2,000
Set-up	\$200	Utilities	\$1,000
Design Parts	\$500	Insurance	\$2,000
Safety	\$500		
Durability	\$500		
Sum	\$2,400	Sum per year	\$212,400

As we can see from table above, majority of expenses are over employees. Product design and assembly is relatively simple and less time consuming. Success of this business heavily depends upon marketing skills. Manufacturing of casing will be done at vendor with injection molding facility. Developing a good vendor is necessary. We will provide the raw material required for manufacturing casing to ensure casing quality as per design specifications, only labor work will be subcontracted.

Following is the detailed Bill of Material for manufacturing product.

Sr.No.	Component Description	Component type	Manufacturing Process	Weight/Component	Quantity / product
				kg	pieces
1	FM transmitter	Purchased		0.01	1
2	Mic	Purchased		0.003	1
3	3.5mm Male connector	Purchased		0.001	1
4	3.5mm Female connector	Purchased		0.001	1
5	Casing	Manufactured	Injection Molding	0.001	1
6	Soldering wire	Misc		0.0001	1

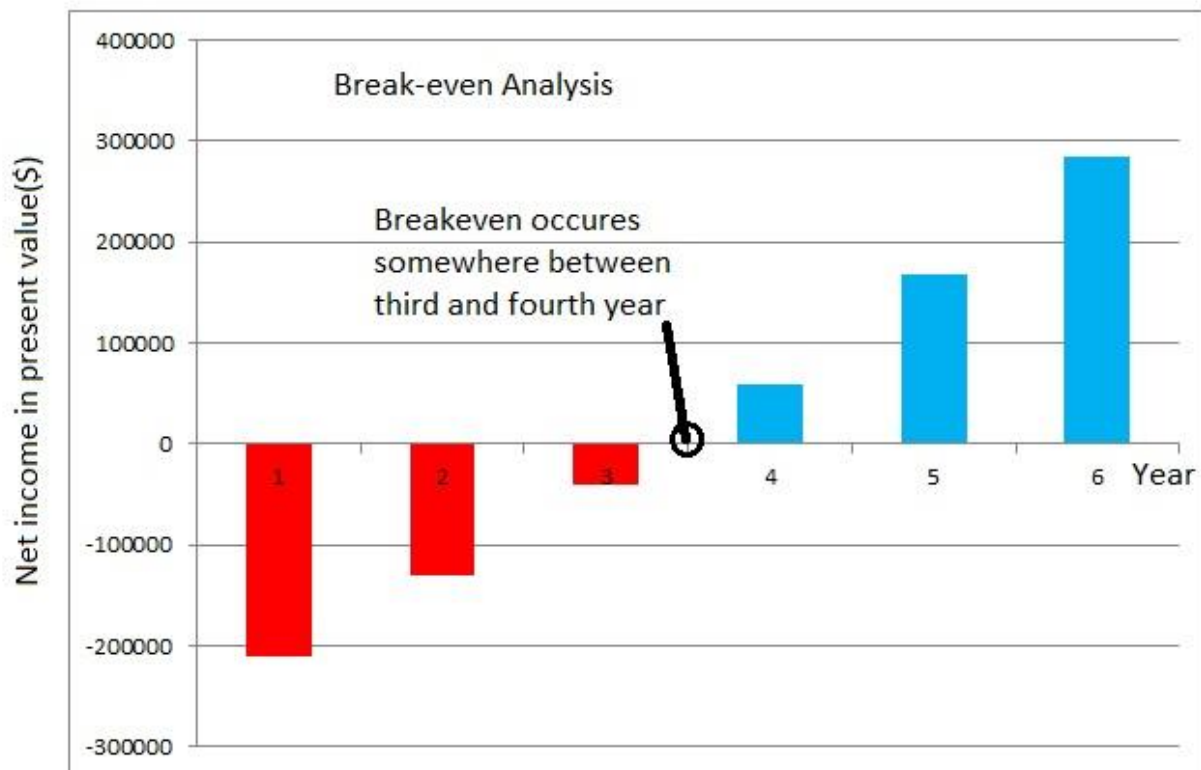
Initial investment cost, cost per year, cost per part can be referred from the table below

Item	Use	Cost (Initial)	Cost (per year)	Cost (per part)	Details of Cost
Electronic workstation	Manufacturing	1000			
Assembly and Packing station	Manufacturing	1000			
Inventory stores	Manufacturing	1000			

line worker 1	Manufacturing			0.3	\$18/hr, \$0.3/part
line manager 1	Manufacturing			0.33	\$20/hr, \$0.3/part
Salaried worker 1	Marketing		80000		
Salaried worker 2	Business Administration		80000		
production space	Property	10000			
office material	Office needs		350		
mold part from supplier	Manufacturing				
part material	Manufacturing			3	
Phone/Internet	Office needs		500		
Energy cost	Property		350		
unexpected costs	Misc.				
Attribute additional				0.5	
Number of parts annual	50000				
Sum		13000	161200	4.13	

## 2.2 Break-even analysis

Break-even occurs somewhere between third and fourth year. Details of pro-forma income and cost projection are given in section 2.3.



## 2.3 Pro-forma income and cost projection

Project year	0	1	2	3	4	5
<b>Income</b>						
Investor contribution	210000					
Total sales	0	50000	55000	60500	66550	73205
Sales revenue	0	500000	550000	605000	665500	732050
<b>Expense</b>						
Initial cost	1000					
Cost of product	0	150000	165000	181500	199650	219615
Fixed operating cost	210000	210000	210000	210000	210000	210000
<b>Net profit</b>	-1000	140000	175000	213500	255850	302435
Post-tax profit	-1000	85400	106750	130235	156068.5	184485.35
Running cash balance	-1000	84400	191150	321385	477453.5	661938.85
<b>Present value conversion</b>	-1000	79622	170122	269841	378187	494639
<b>Breakeven</b>	-211000	-130377	-39877	59841	168187	284639

Pro-forma analysis is based on following assumptions.

1. Price per product - \$10
2. Cost per product - \$4.13
3. Starting sale - 50000 per year
4. Sales growth rate - 10%
5. Tax rate - 39%
6. Discount rate - 6%

### **3. SUPPORTING DOCUMENTS**

#### **3.1 Existing Patents and reasons for why our product would not breach them**

##### **3.1.1 Automated touring information systems and methods (US 6085148 A)**

Description: An apparatus for automatically disseminating information corresponding to a location includes a location identification device for providing a current location, a presentation device for presenting the information to a user, a controller operably connected to control the presentation device, and a storage device operably connected to the controller for storing the information and predefined location data linking the location to the information. In one embodiment, the controller may include a processor programmed to receive the current location from the location identification device and compare the current location with the predefined location data. The apparatus may further include a memory device containing data structures including the current location data corresponding to a current location, the predefined location data, a comparison module for reading the current location data and comparing the current location data with the predefined location data, and a presentation module for controlling the output of the information to the presentation device from the storage device.

Why our product will not breach the above-mentioned patent:

a) Our product does not consist of any 'location identification device' to identify the location of tourists in museums, instead we are using same FM frequency for every location (of FM transmitter) and each FM transmitter will have its own specified range in which only it will transmit information.

b) We are not using a presentation device to present the information to the user/tourist, instead we are transmitting pre-recorded information repeatedly, and tourist can choose if he/she wants to listen to that information by simply turning on/off their FM receivers.

##### **3.1.2 Smart airport automation system (US 6950037 B1)**

A smart airport automation system includes a subsystem that inputs weather and airport configuration data to determine an active runway in use and an airport state. Another subsystem inputs aircraft position and velocity data from available surveillance sources, known flight-intent information, and past aircraft trajectories to project future aircraft unconstrained trajectories. A third subsystem uses the projected trajectories and aircraft



intent to determine desired landing and takeoff sequences, and desired adjacent aircraft spacing. A fourth subsystem uses such information to predict potential aircraft conflicts, such as a loss of acceptable separation between adjacent aircraft. A fifth subsystem packages the weather, airport configuration, aircraft state, desired landing/takeoff sequence, and potential conflict detection into a verbal advisory message that is broadcast on a local common radio frequency. A sixth subsystem uses the projected trajectory information to control the runway and taxiway lighting system.

Why our product will not breach the above-mentioned patent:

a) Our product will be more helpful for travelers as compared to the above system which is more helpful for 'Air Traffic Controllers'.

b) Our product will give information regarding gate number of a particular aircraft, flight's arrival and departure timings, terminal configuration etc. instead of giving information about flight trajectories, runway and weather conditions like 'Smart airport automation system'.

c) We will not be controlling runway and taxiway lighting system.

### 3.1.3 Audio visual teaching system (US 3245157 A)

The students learning process may either be aided or hindered by communicative level selected to present educational material. This is especially true of the vocabulary chosen. A major shortcoming of presently used educational television facilities has been that it is an open loop system, with the instructor presenting the educational material having no information fed back to him as to whether he is communicating with his students. Consequently, since there are no available or practical means for student feedback, the programmer must guess at suitable or compromise communicative level to present the intended material. If the programmer selects a level or vocabulary of too high sophistication he will invariably lose a great number of students lacking a commensurate vocabulary. Alternately, if the programmer selects a communicative level of too low a level of intelligence many of the students, especially the more capable students, will lose interest in the material being presented.

Why our product will not breach the above-mentioned patent:

- a) We are not using close loop system as it is used in above mentioned system as there will no feedback sent to Professor in our system.
- b) This system basically emphasizes on vocabulary level (High/Low) and our system tries to rectify the audibility problems in classrooms by transmitting Professor's voice on a FM frequency using FM transmitter.
- c) Above mentioned system identifies student and give output (vocabulary, intelligence level) according to it and our system ensures that every student hears properly.

#### 3.1.4 System and method for on-line interactive lectures (US 20090006410 A1)

A system and method for implementing on-line interactive lectures are provided. The video and audio lectures are delivered to geographically dispersed students through the internet. The delivery may be performed in two different modes, which are live-broadcast (live lectures) and on-demand (archived lectures). Live-broadcast lectures are delivered to students in real-time while the lectures are recorded. The students may interact with the teacher and other students using real-time communication methods. The real-time communication methods include text-based on-line chat, and video/audio conferencing systems. On-demand lectures are delivered to students on per-request basis. The students may interact with the teacher or other students using non-real-time communication methods. The non-real-time communication methods include message boards and emails. The system may collaborate with a learning management system (LMS) to control the level of access over the video/audio streams and communications.

Why our product will not breach the above-mentioned patent:

- a) We are using In-Person teaching method and above system uses online teaching/learning method.
- b) This system uses on-line chat, video conferencing method for communication while we will be using FM transmission.
- c) Our product uses one-way communication as information is transmitted from Professor to student and there is no reversal but above mentioned system is a Two-way

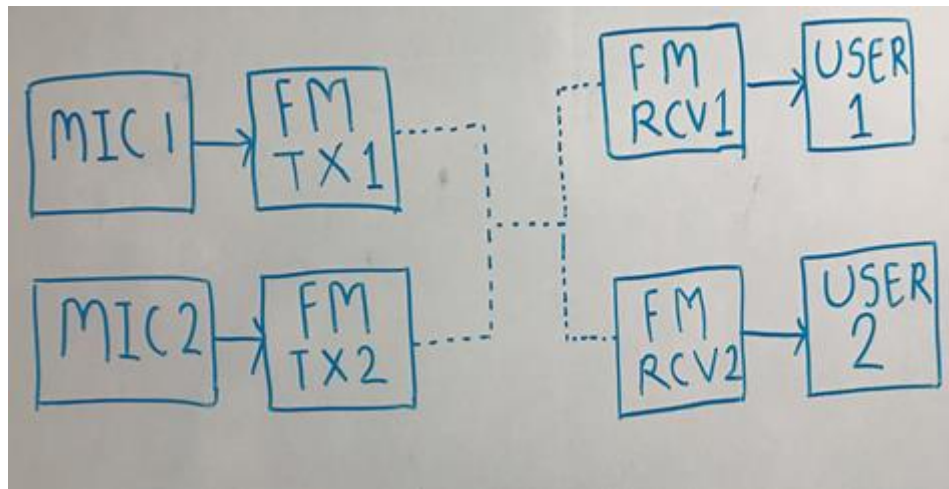
communication system as students can also interact with professor using E-mails and Text messaging.

### 3.2 Technical Analysis

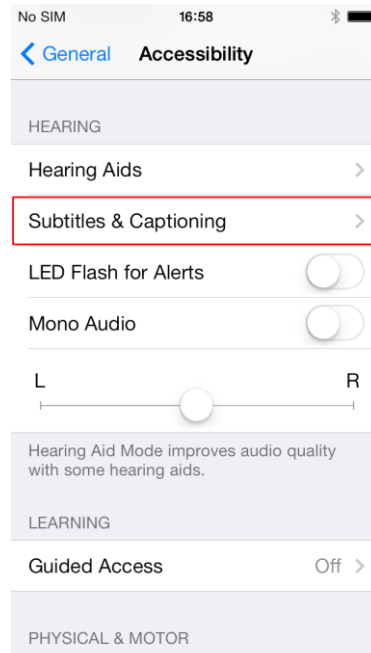
The objective of our product is to resolve the issue of audibility in every single domain and provide solutions to it by a mix of few products. Three focus was:

- Ambient sound without location constraint
- Noise cancellation
- Auto volume adjust

Using existing technology of radio devices with lower range of about classroom size resolved the issue of ambient sound without location constraint. These days everyone carries a smartphone hence a smartphone could be used as a radio receiver of audio file and our product scope will be to provide an app that can not only play radio signal but also record it or provide live subtitles and also language translations.



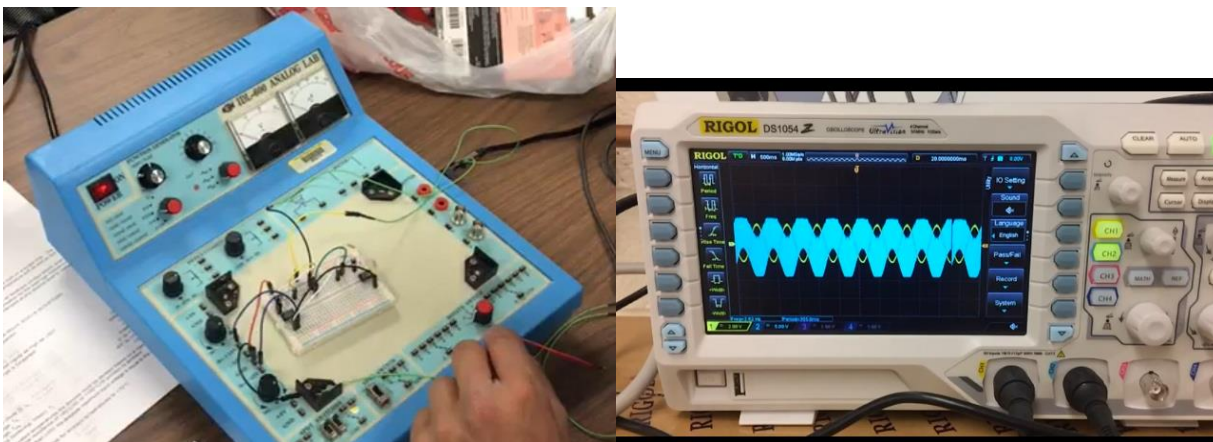
*Circuit diagram of radio transmitter and receiver*



*Radio Transmitter and personalized phone and app*

There was no lag in speech and audio signal played via smartphone. Hence every individual can choose to hear the audio volume of their own choice. This resolves the issue of audibility and space constraint considering the conventional speaker.

Noise cancellation is very tough task to obtain especially when the noise source is multi source. There is no current mass produced product which can obtain noise cancellation in a 3D space with multi source noise. The technology that we incorporate to cancel noise is using a mic and op-amp circuit to detect a noise and create phase inverted signal to cancel the noise in a 1D direction.



*Noise cancelling circuit and oscilloscope inverted signal*

This technology is already existing in high end headphones but none of these headphones are popularly used in live audio signals. This attribute will give our product a sophisticated feature to ensure audibility in high noise environment.

Auto Volume adjust is existing in few products which have constrained location such as a car or a movie theatre or Modern Television set. But none used popularly in a classroom or other live audio environment. This technology eliminates the need of adjusting the volume button for almost 80% of time. The auto volume adjust will detect if the mic signal strength is low or high and multiply a k-factor which will keep the audio output in an ambient range.

With these wide range of solution on audibility eliminating space constraint, wireless audio signal, storing, subtitles and translation of audio with noise cancellation and auto volume adjust, our product seems to have resolved the audibility issue at each level.

### 3.3 Benchmarking

The table below shows the comparison of our products with the existing solution in the world. We are trying to make it more cost efficient with high clarity and quality and minimal maintenance.

Products/ Attributes	Audio Control System	Automated Touring Info System	Smart Airport Automation System	Silent Disco
Cost	10	80	100	200
Sound Clarity	High	High	Intermediate	High
Maintenance	Low	Low	Intermediate	Intermediate
Product Quality	High	Intermediate	High	Very High

Our product is the most cost efficient compared to the other products,since FM transmitter is the only main component in our product. The only maintenance in our product will be to change the battery of the FM transmitter when it drains out. People

will be using their own personal use headphones to listen, so it will give more clarity and comfort. So overall our product, Audio Control System is the better option here.