



FOM Hochschule für Ökonomie & Management

Essen

Assignment

in the study course Big Data Analysis

to obtain the degree of a

Master of Science (M.Sc.)

on the topic

OSMI in context of Audio Analysis

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Submission Date : *26-08-2021*

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Table of Contents

Index of figures.....	III
Index of tables.....	III
List of abbreviations.....	IV
1. Introduction.....	1
1.1. Problem Statement.....	1
1.2. Research Questions.....	2
1.3 Expected Output.....	2
2. Theoretical Foundation.....	2
2.1 Definition of Multisensory marketing.....	2
2.2 Importance of five human sense in marketing	3
2.2.1 Auditory.....	5
2.2.2 Visual.....	6
2.2.3 Olfactory	6
2.2.4 Gustatory.....	6
2.2.5 Tactile.....	7
2.3 Multi-Sensory Branding.....	7
2.4 The Nyquist Theorem	8
3. Research Design.....	8
3.1 Definition and concept of structured literature analysis.....	8
3.1.1 Traditional approach versus structured literature review approach	13
3.1.2 Structured literature analysis definition.....	14
3.1.3 Preferred literature review approach	15
3.2 Structured Literature Analysis	15
3.2.1 Collection of Literature	16
3.2.2 Shortlisting of Literature	16

3.2.3 Selection of Literature.....	17
4. Research Results	24
4.1 Process of extraction of Audio data:	24
4.2 Process of Audio analysis.....	25
4.2.1 Using Amazon Transcribe.....	25
4.2.2 Using the Python Code.....	25
5. Projection of Results	36
5.1 Limitations:	37
6. Conclusion and Outlook	37
Bibliography	38

Index of figures

Figure 1: The Firm, Five Senses and Individual	4
Figure 2: Loading Librosa Library	27
Figure 3:Extracting sample audio length	27
Figure 4: Importing Audio	28
Figure 5: Plotting graph with Amplitude against Time(Seconds)	28
Figure 6:Fourier transform.....	29
Figure 7: FFT Algorithm Overview	30
Figure 8:Interpreting the sample in Waveform	31
Figure 9: Sine graph of Amplitude vs Time	31
Figure 10:Interpretation of Time vs Amplitude with frequency at 11.	32
Figure 11: Sine Wave of Time vs Amplitude at 11 frequencies	32
Figure 12: Combining the outputs.....	33
Figure 13: Plotting the output.	33
Figure 14: Code for Fourier Transform.....	34
Figure 15: Code for Scale Frequency	34
Figure 16: Code for Spectrogram.....	35
Figure 17:Plotting the Spectrogram	35
Figure 18: Visuals of Spectrogram with frequency vs. time.....	36

Index of tables

Table 1: Sensors, Sensations and Sensory Expressions Source	4
Table 2: Literature selection and their key findings.....	17

List of abbreviations

S3: Simple Storage Service

OSMI Online Sensory Marketing Index

B2C Business to Customer

B2B Business to Business

SLR Structured Literature Analysis

FT Fourier Transform

FFT Fast Fourier Transform

DFT Discrete Fourier Transform

1. Introduction

Sensory marketing has been around since the early 20th Century where the earlier retailer and marketers were selling their products by letting the customers sense the products in the form of touch, smell, and taste¹ (E.g., Feeling the textile texture, tasting a dish, sweet or other edible foods and setting the mood at the stores with a distinct perfume)² which helped retain customers for a longer time and increase their purchases. Later around 1930s, A company named Muzak hired bands to record music³ for the retail chain which led to the music influencing the customers and increase in sales. Later, Online Sensory Marketing came into existence that has been incorporating new ways to attracting customers using different sensory marketing methods but mostly its visual and auditory because still the Olfactory, Gustative and Tactile marketing have not made available with technology.⁴ But that is usually balanced with the help of Audio and Visual by describing the content played or displayed. Here the research is about how one can understand what goes on in making a good audio advertisement that it helps sell a product by influencing the customer. Audio files are analysed for understanding the features embedded in them like, background, ambient and other sounds that might directly or indirectly influence the customer in thinking or searching about a product and then finally purchasing it. Further analysis of Waveform and Spectrogram is done to understand the audio forms used.

1.1. Problem Statement

In today's online market there are not enough research on how online marketing in context to audio sensory is being done. Also, not much analysis is done on audio to understand its usage in OSMI.

¹ Asioli et al. 2011

² Krishna et al. 2017

³ Hwanget al. 2020

⁴ S. Hussain 2019

1.2. Research Questions

What are the features in audio files and how they are incorporated in audio advertisements that influence the customers likeliness towards a product?

1.3 Expected Output

Analysing the existing repository of audio and identifying the key factors or features embedded in them that make the advertisements stand out from the rest.

2. Theoretical Foundation

2.1 Definition of Multisensory marketing

Sensory marketing is a marketing strategy that uses multi-sensory experiences to create positive emotional connections with consumers. Marketers are often looks for emotional and personal connections with the customers. Brand personification is important for brands to be remembered in a particular way. As a result, multi-sensory marketing is becoming increasingly popular in the marketing industry. Using the five senses of sight, sound, smell, taste, and touch to market a product is called sensory marketing. A multi-sensory approach should be considered for all buyer stages: brand awareness, product promotion, consideration (trial), purchase and post-purchase (after the purchase). Whatever business model is, whether B2C or B2B, tangible or intangible brand, this applies to everyone. Branding, messaging, products, and consumer experiences all have sensory effects on your target audience. Through experiential marketing, a marketing strategy that engages consumers directly and invites them to participate in a brand experience, we can engage the five physical senses in a meaningful manner. In what is known as live event marketing or experience marketing, advertisers use various media or happenings to immerse consumers in a story. ⁵

Emotional, behavioral, and cognitive responses are triggered when the senses are activated. Our senses help us make sense of the world and our surroundings.⁶ There are

⁵ Krishna & Schwarz 2014

⁶ Krishna et al. 2017

five senses, and each has its own way of influencing how people perceive what they see (including brands). With the help of their senses, you'll be able to break through in new ways.

It's important for a balanced media mix to include elements that can't be overlooked. Through consumer involvement, brand experiences and live events enhance a company's advertising and marketing strategy. This is a powerful way to engage customer because they engage all five senses at once. As a result, multi-sensory marketing sets the mood and tone for any business. In order to create a more personal connection, it is to be considered how someone will physically and emotionally experience the brand.

2.2 Importance of five human sense in marketing

This emerging field of study aims to gain a better understanding of consumer behavior by studying the sensory, emotional, and cognitive functions of the human brain.⁷ Using multi-sensory experience, consumers may be able to perceive advertising in a conscious way. To a certain group (niche market), the product's experience is more important than its price because a product can tap into a customer's emotions and feelings.⁸ To understand how it effects a consumer and brands using this sense for marketing by understanding some events like:

Dunkin Donuts ran a campaign in Seoul, South Korea where commuter buses in the city were outfitted devices which releases the aroma of fresh coffee whenever they play Dunkin Donuts jingle on radio. At the end, the buses get stopped near to the Dunkin Donuts outlet which effects and urges human sense to buy from Dunkin Donuts.

Another Example is when someone go the store to buy candle store than one might get experienced the smell even though none of the candles are burning. The scent of the

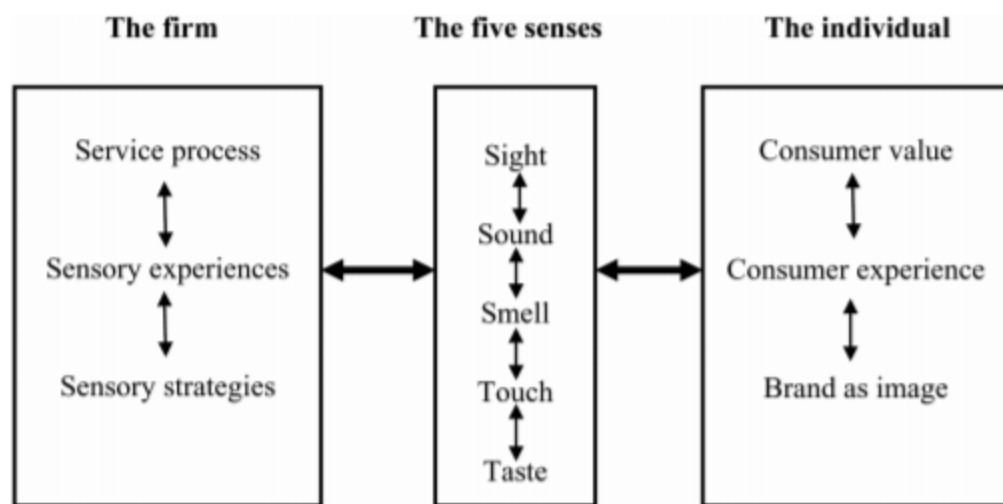
⁷ Hultén 2017

⁸ NandagopalR 2015

candles intended to complement the visuals on offer so people subconsciously imagine the relaxing and pleasant ambiance that the candle could create in their home.⁹

Likewise, this sense intended to influence our senses so that we can feel the comfort and use that brand.

Figure 1: The Firm, Five Senses and Individual



Source: ¹⁰

Table 1: Sensors, Sensations and Sensory Expressions Source

Sensors	Sensations	Sensory Expressions
Smell Sensor	Atmospheric	Product congruence, intensity and sex Atmosphere, advertency and theme Scent brand and signature scent
Sound Sensor	Auditory	Jingle, voice and music Atmosphere, attentiveness

⁹ Dio 2019

¹⁰ Hultén 2017

		and theme Signature sound and sound brand
Sight Sensor	Visual	Design, packaging, and style Colour, light, and theme Graphic, exterior and interior
Taste Sensor	Gastronomic	Interplay, symbiosis and synergies Name, presentation and environment Knowledge, lifestyle, and delight
Touch Sensor	Tactile	Material and surface Temperature and weight Form and steadiness

Source: Nandagopal R 2015

2.2.1 Auditory

Music lovers know that sound can be incredibly powerful in evoking emotions and triggering recollections in listeners. The ping of Intel, the growl of a Harley Davidson engine, the tune of Britannia, the jingle of a blackberry (we are blackberry boys), and so on and so forth. Through the use of sound, the companies hope to establish a strong connection between their customers and their brand. The goal is for the customer to associate a particular sound with a particular brand whenever they hear it. There is a direct correlation between the type of music played and overall satisfaction, according to other studies that have been done. The Sunburn concerts and other world-wide events¹¹ come to mind. Hearing is a very complex system in terms of its anatomy and

¹¹ Gemmeke et al. 2017

connectivity, with multiple stages of processing that involve complex interactions between inputs and existing memory and experiences, in addition to interactions with other sensory systems, Music affects mood, shopping pace, and actual time spent in the store. Use of English in advertising has become associated with modernity, sophistication, progress, and a cosmopolitan identity, according to a recent study.

2.2.2 Visual

When it comes to identifying a brand (logo), sight is the most important sense. As a result of this, the ventral pathway (what) and dorsal pathway (where) in the brain are named (where). In order to process visual features such as colour, orientation and motion texture, the brain uses stereoscopic depth. A first impression is often formed based on a person's sense of sight. Lighting plays a major role in the perception of objects. The Greeks recognized the relationship between the eye and the objects seen as early as the 5th century BC. Aristotle, in the 4th century BC, rejected the idea that vision was produced by a fire in the eye, arguing that if vision were produced by a fire in the eye, we would be able to see in darkness. Even though our day vision is colour-blind, our night vision is not. "

2.2.3 Olfactory

Olfactory studies show that odours can be used as a marketing tool by making customers feel comfortable and relaxed. This is a reference to the Proustian effect. It's named after the brilliant author Marcel Proust, who wrote novels and essays in the early 1900s. According to a study, schoolchildren who are exposed to a positive scent perform better. For its cabin crew, employees, and passengers, Singapore Airlines created its own proprietary scent in 1990, and infused it into the hot towels they gave out to travellers. Profits of \$153 million were made in 1991, an increase over the previous year. Because the scent is now perceived as Asian and feminine, it reminds travellers of smooth, comfortable journeys. This is a testament to the success of this sensory branding tactic.

2.2.4 Gustatory

Humans detect taste with taste receptor cells in the brain, as do all other senses. Salty, sour, sweet, bitter and umami are the five primary taste sensations (savory flavour

found in mushrooms, soya sauce, sea foods, etc.). Nahrungsmittelindustrie is a well-oiled machine that can be exploited to meet regional tastes. A close relationship exists between somatosensory perception and the oral sense of taste. Studies show that perceived food quality has a direct correlation with consumers' intentions to become regulars. Restaurants must make it very clear to customers what they can expect from them. People with different dining motivations are more likely to evaluate the experience in a different way, which could lead to dissatisfaction in the end. Also, consumers tend to associate certain meals with pleasant memories from the past. As a result, when restaurants start serving these dishes they automatically become part of these evocative personal memories. Aside from their special flavor food, Singapore Airlines is known for their Asian-inspired chicken rice.

2.2.5 Tactile

Product sales are largely driven by the product's feel and touch. The apparel industry relies on this fact to survive and thrive. One of the main reasons why people don't like online clothing shopping is because they can't feel or touch the fabric. As a result of psychological research, consumers are more likely to purchase products after they have felt them in their hands. Amazon has a good reputation in online shopping because they only sell books, which don't need to be touched. Sure, the smooth, silky surface of an advertising ad in a magazine creates an emotional connection with the advertised product. It has been suggested that an aging population seeking taste sensations to stimulate taste buds and olfactory nerves is driving our increasing desire to consume extreme flavour. Most notably, in the food and beverage category, where previously intense or exotic flavours had been accepted by the general public, taste thresholds are continuing to increase. It's been just five years since McCormick began selling its extra-hot chipotle pepper, and sales are up 70%. Sensory nerves transmit information from the receptors to the brain via spinal cord tracts.

2.3 Multi-Sensory Branding

This type of brand experience generates certain beliefs, feelings and opinions in the consumer's mind that are used to create a brand image. More than one sense contributes

to the perception of sensory experiences.¹² Individual value creation is supported by multisensory brand experiences, which take advantage of the five senses to generate customer value, brand experiences as well as brand image. During the transition to a multi-sensory experience concept, brand identity has shifted from 2D to multi-5D. In other words, five-dimensional branding is a brand experience that can't be obtained by magnifying one sense.¹³ At Ferrari World in Abu Dhabi, visitors can immerse themselves in Ferrari's Italian heritage through the sights, sounds, and smells, and take rides that simulate the G-force of Formula 1 racing. Multisensory brand experiences are a priority for pioneering brands. Nissan plans to introduce in-car aromatherapy forest air conditioning, which will deliver scents that assist in maintaining alertness and deliver vitamin C to help hydrate human skin. What's interesting about these examples is how they demonstrate how physical sensations can create deeper emotional connections by activating people's primal needs and desires. Bonded senses act as catalysts in the creation of synergy, which is essential for senses to interact with and bond with consumers.

2.4 The Nyquist Theorem

Nyquist theorem is one of the most important rule of sampling theorem. According to this theorem the highest frequency of any signal which can be represented accurately is one half of sampling rate. It specifies the minimum sampling rate which can fully describe a signal.¹⁴

3. Research Design

3.1 Definition and concept of structured literature analysis

A literature review is a study of various scholarly resources that include secondary sources like published articles, scientific journals, and white papers. These resources provide an overview of current research and its gaps in the specified topic which would

¹² *Multisensory marketing is the future* 2015

¹³ Pawaskar & Goel 2014

¹⁴ Mishonov et al. 2018

set a foundation for new research. An authoritative literature review, "generates a strong stand for growing knowledge." It helps to create theories, plugs gaps where there is a lot of study, and uncovers places where further research is needed." This chapter gives a holistic view on different literature review approaches and its structure, the purpose of a literature review, steps involved in a literature review, structured literature review and its advantages, and adopted methodology for the current research.

Literature Analysis Purpose

The first phase involved in conducting a literature review is to define the review's purpose. This initial phase, strictly speaking, is more of a consideration of the technique to be used than it is a component of the active procedure. The first step in any empirical study should be to determine whether the approach to be used is the most appropriate one. The goal of the literature review should address the question, "Why conduct a literature review?" in such a circumstance.

Literature analysis helps to better understand already available research and discussion on a unique subject matter or a discipline of study, and to offer those statistics with inside the shape of a written report. Although it might be a great way to start determining how much literature is available, subjects such as these generate a lot of information, making a review unfeasible.

As a result, it's a good idea to optimize this even further so that the final data that is collected is manageable and to identify which characteristics are particularly important to narrow the area of interest. The particular aspect of this part is interesting and determining what is of specific importance to improve subject optimization. Discussion with others, including research specialists, or researching about a topic can also assist in establishing which aspects of the subject the reviewer is intrigued in, as well as how much information is available on the issue. It's also essential to have sufficient literature, specifically if the review is for a scientific journal. Gathering sufficient literature is essential for performing research and evaluation and to make sure there is enough data to fulfil the demands. Topics that are too different and broad will result in either absurdly long or superficial evaluations. so it's better to begin with a focused and concentrated topic and then broaden the scope of the review as desired.

Conducting a literature review contributes to the development of the field expertise. Key aspects, research methodologies, and experimental techniques applied in particular discipline will be examined. Another advantage of literature review is that we can always gain a higher know-how of the way study's findings are supplied and mentioned in a specific discipline. Recognizing the current situation, literature reviews are repeatedly perceived at the beginning of research journals. This is since a literature review notifies the person who reads about where the researchers currently stand on a given topic and reveals research gaps. The study article then uses new research to bridge the gap. A literature evaluation is utilized by researchers to understand regions of a subject which have now no longer but been very well investigated. They then proceed to conduct research in order to narrow the gap in the literature. Compare and assessment every supply with different applicable literature at the issue; seriously examine every supply; discover how every supply contributes to the frame of know-how on the subject; comprise the attention of the reasserts into the argument approximately the nation of know-how on the subject are a number of the stairs concerned with inside the studies process. Therefore, it is important to organize the literature review report so that it displays how we evaluate the sources in terms of how they relate to each other and to the compelling strengths on the subject.

The main objective is to examine and synthesize the present qualitative and quantitative approach of the research topic. A review of the present literature with a critical eye to determine the importance of your study selective, yet significant enough for your effort to be judged in light of what is already known. To identify 'gaps' in the field / to establish a research space. There are no fresh additions to the literature.

Quantitative Approach

- It is useful in conceptualization and execution of a research project
- Provides context and justifications as to why the subject is worth investigating
- Is conducted both before and after the study in order to collect any material published
- while the study was being carried out.

- Relevant sources may indeed aid in the interpretation of research findings by researchers.

Qualitative Approach

- Attempt to manage expectations and bias in data collection, processing, and interpretation of findings, while it may not be substantial.
- There will be no further review after the study is completed.
- The duration and scope of the review would also be determined.

Steps in literature review

This section will expound on strategies by illustrating the procedures required to accomplish advanced excellence literature search result, i.e., greater efficient outcomes.

1. Find relevant books on the desired subject.
2. Select and evaluate the sources of information
3. Determine themes, trends, and patterns, as well as arguments or inconsistencies, important research, and gaps.
4. Plan out the structure of the literature review.
5. Compose the review

Step 1: Find relevant books on the desired subject.

Selecting a review topic might be a challenging feat. The choice of a comprehensive review title is a common error committed by novices. As a result, select a topic about which you are knowledgeable and enthusiastic. Current, well-established topics with a significant volume of research available for evaluation. Topics that will interest the readers' and other academics' interest.

Step 2: Select and evaluate the source of information

Make a list of the criteria required for choosing the appropriate sources (i.e., publications from a given time period, focused on a specific geographic place, or employing a specific approach). Conduct a thorough search of a library database using keywords. Recent article and review reference lists can connect to more important

studies. Include any studies that contradict the viewpoint. For example: Scholarly articles, books, and papers.

Step 3: Analyse the network of information and selected works

To find research intersections and outline essential categories, use thought maps and charts. It is advised to choose the materials that will be most beneficial to the review.

Step 4: Plan out the structure of the literature review

Make a list of 2-3 key concepts or discoveries presented in each text; generate a checklist of important details. Findings that are both common and controversial, the most important research trends, the most popular theories. Most, but not all, researchers appear to make assumptions, Researchers use methodology, testing processes, individuals, and information that has been tested. Names that are frequently mentioned by professionals in the field. Theories, results, and procedures that contradict each other. The popularity of theories, as well as how it has developed (or not) over period.

Step 5: Compose the review

Show how the principles of literature relate to observations and establish links between literature. Identify the gaps in existing research that your work fills in. Concepts that support your hypothesis, techniques, results, or conclusions should be highlighted. Identify challenges that have been overlooked in past studies. Determine what is accurate and what is not within the scope of these works. Researchers believe that higher conceptions should be retained and that they should explain why. They should be able to explain, analyse, and delight. Others argue that they should be interesting, but also practical, falsifiable, and beneficial. Some think that theories should be constructed using a variety of paradigms. As a result, they should demonstrate originality, relevance, and comprehensiveness. Thereby, the above study defines the literature review process as: sequential steps to collect, know, comprehend, apply, analyse, synthesize, and significant involvement studies as a way to provide a basis for themes and research methods, it is mainly based on the description of a strong literature evaluation and the definition of the method presented here.

3.1.1 Traditional approach versus structured literature review approach

In any type of literature review, a thorough empirical approach is required. In order to have an effective literature review for research, there exists numerous approaches, of which this section gives the steps involved to carry out an effective literature review for the research, traditional or narrative, structured literature review approach and their comparison in terms of advantages and weaknesses of both in the context of scientific research.

Traditional Approach

A traditional literature review is a summary of what is known about a specific topic. They analyse the information rather than merely restating it, but the methods they use are rarely indicated in advance, and they are rarely discussed in depth in the review. Traditional approach qualitatively summarizes data on a topic by collecting and interpreting studies using informal or subjective approaches. Although the search is broad, it is not intended to be exhaustive. A conceptual method is utilized in literature reviews, and that they often take the form of a discussion. The author aims to demonstrate their understanding and potentially present their work in the context of the past takes precedence over precision and reproducibility. This type of synthesis frequently leaves no room for the author's own bias. A literature review's results, or conclusion is more likely to be communicated using words than statistical approaches. Key attributes of traditional literature review include Thematic approaches which are used in literature reviews. The author's personal views may have an impact on the conclusions. A traditional literature review's objective would be to get a better understanding of existing literature studies and discussions on a particular subject matter or vicinity of study, and to offer the applicable statistics with inside the shape of a written report.

Structured Approach

A systematic review is an assessment of all primary research studies conducted on a specific topic of interest. The study or research must first seek or evaluate literature in all available data bases in order to conduct a systematic literature review.

The review's procedures are described as “systematic”, and it implies that they are transparent, reliable, and defined prior to the commencement of the search. High-level

evaluation of top-ranked research on specific topics, identifying, selecting, synthesizing, and evaluating all outstanding research statistics applicable to the topic. This is significant because it helps to reduce the bias that would arise from cherry-picking research in an ad hoc manner.

Key attributes of structured literature review include systematic reviews that adhere to a set of guidelines. The procedures are clear and consistent, the review team evaluates the quality of the evidence and makes every attempt to eliminate bias, the evidence drives the findings and conclusions. The goal of Systematic Literature Review is to eliminate bias by responding to a specific question. Systematic literature reviews attempt to discover as much relevant research on a specific research topic as appropriate, and to utilize specified procedures to determine what can be asserted with confidence based on these findings. Methods should not only be plain, but also systematic, in order to produce a wide range of consistent outcomes.

3.1.2 Structured literature analysis definition

Scientific review of literature is carried out for a myriad of purposes. They include establishing a theoretical framework for successful investigation, comprehending the spectrum of research on a particular issue, and addressing practical questions by comprehending what existing research has to say about the subject. A large proportion of literature reviews are comprised of a fundamental research article that establishes the theoretical groundwork for the main study that is the article's objective.

The rest of a scholarly article is substantiated by a literature review. It describes the content and quality of existing knowledge and makes the reader aware of the importance of earlier work. The findings are explained in order to provide a foundation for future investigation. Such reviews will eventually make their way into a variety of roles, including grant and funding proposal justification; assisting practitioners in making informed professional judgments; identifying important individuals, techniques, or expertise; and introducing less commonly accessible information. The review, as an academic document, cannot merely recapitulate the subject matter; rather, it must contribute to the work by synthesizing the information available and delivering a scientific evaluation of theory. Novice researchers often think of the literature review as a long-term annotated bibliography for any other series of abstracts or many research

reports. A comprehensive review of the literature includes more content. Literature evaluation is "using ideas from the literature to test topic-specific methods, choosing methods, and showing that research contributes to the legitimacy of some new things." In addition, "by using literature standards to test subject-specific methods. Reasonableness, method selection and testing, which can create value."

For the literature assessment, he also emphasized that "quality includes proper scope and depth, integrity and coherence, transparency and readability, and good problem". The review process, according to J. Shaw, "one part of research build another part."

3.1.3 Preferred literature review approach

For all research disciplines and projects, prior, relevant literature must be considered. When studying an article, the writer starts with the aid of using discussing beyond studies to map and examine the studies area, encourage the study's goal, and justify the studies query and hypotheses, no matter discipline. Therefore, in order for a literature review to become a competent research methodology, a certain process must be performed, and action implemented as with any other research to ensure the review is comprehensive, precise, and reliable. The researcher can undertake a number of methodologies, standards, and recommendations designed in particular for acting a literature review, relying at the scope of the review. The above aspects are needed for a research to be smooth and the method that satisfies/ includes the above aspects is Structured Literature Review. We use a Structured Literature Review (SLR) approach, as defined by Massaro et al., to develop our research (2016). "A process for analysing a corpus of scholarly literature in order to create insights, critical reflections, prospective research approaches, and research questions," according to the SLR definition.

3.2 Structured Literature Analysis

This section provides an idea on how the audio analysis and other sensory analysis influence the online sensory marketing and previous research of other ways of analysing audio. This section also provides a brief idea about the process used different researchers on analysing audio using classification and detection of scenes and acoustic contents.

Our objective of literature analysis was to:

- Gather information regarding different form of audio analysis.
- Influence of audio in Online Marketing Analysis.
- Understanding different approaches used to analyse audio.

3.2.1 Collection of Literature

There were a wide variety of sources available to gather the literature that was required for further working on this topic. However, the focus was to extract literature from sources that deemed understandable and accessible to our needs.

- We conducted a search using keywords on different platforms like Google Scholar, Research Gate, Wiley, Springer and Science Direct.
- Also, we used the Google search engine, Science Direct, IEEE and Elsevier to collect literature from articles, books, and journals.
- We have also used some Google search operators to widen our search example all in the title, in URL, entitle, etc.
- We are grateful to our university, “FOM Hochschule for Economies & Management Essen,” which has helped us to have access to various journals available on the internet. We have also used the references of some of the journals and books from EBSCO.

3.2.2 Shortlisting of Literature

We have shortlisted literature based on the following criteria.

- Availability of keywords
- Authenticity of resources
- Preference to the articles and journals published in the past 7 years.

Initially all selected journals were skimmed by reading the summary or abstract and heading to see how they influence our study.

In the next step the approach used in the literatures were taken into consideration and how it may help in our analysis.

3.2.3 Selection of Literature

The selection of literature is based on the below criteria and the listed Key findings, Factors supporting our analysis and how they are relevant to our research problem?

Table 2: Literature selection and their key findings

Title	Publisher	Literature review	Key findings
Managing sensory expectations concerning products and brands: Capitalizing on the potential of sound and shape symbolism. ¹⁵	Charles Spence Crossmodal Research Laboratory, Department of Experimental Psychology, University of Oxford, South Parks Road, Oxford, OX1 3UD, UK	Research on the topic of symbolism of sound and form has a long history in the fields of experimental psychology and linguistics, but it is only in the last decade or so that researchers really begin to recognize the potential relevance of this field of study. It is suitable for product naming, branding, and packaging design fields. The latest findings in this newly activated field of research show that the sounds present in brands, abstract images of product packages, and even shapes of labels or packaging themselves can be used. Setting subconscious	Sound symbolism; Shape symbolism; Crossmodal correspondences; Congruency; Sensation transference; Multisensory; Packaging; Branding; Labelling.

¹⁵ Spence 2012

		expectations in the consumer's mind.	
Internet Radio: An Analysis of Pandora and Spotify ¹⁶	Corinne Loiacono	This article analyses Pandora and Spotify to find out why they are popular media for users and how effective each site is to meet the needs of personalized radio. And in this paper, user highlight the most important characteristics here in Pandora and Spotify. Two experiments will be conducted. One is objective (self-conductive) and the other is subjective (with a group of college students).	Spotify, Pandora, internet radio, streaming, radio personalization.
Sensory marketing: the multi-sensory brand-experience concept. ¹⁷	Bertil Hultén Kalmar University, Kalmar, Sweden	This article provides an exploratory overview of the brand's empirical concepts of all senses within the SM model that raises questions about traditional marketing models. An important theoretical implication is that the multi-sensory brand experience is the ultimate	Sensory perception, Brands, Marketing models

¹⁶ Schumacher 2014

¹⁷ Hultén 2011

		result of the value creation process between providers and customers.	
Sensory marketing from the perspective of a support tool for building brand value. ¹⁸	Margareta Nadanyiova, 1 Jana Kliestikova, 2 Juraj Kolencik	The purpose of this article is to provide a review of the literature on the issue of multiple foreign and Korean authors. Discuss the essence of the brand, brand value, and sensory marketing, and analyse the use as a support tool for building brand value using secondary research data. Based on this, the author guarantees the loyalty of existing customers, acquires new customers, builds a successful brand, and builds brand value including brand name and positive awareness of the product.	sensory marketing; brand value; consumer; emotions; buying behaviour
Sensory Branding and Advertising Campaigns for	Patricia Ramos Rubio, Agustin Vilchis Vidal,	In this paper, Author tried to introduce an approach from a sensory branding	Sensory branding, advertising campaigns, strategies marketing

¹⁸ Nadanyiova et al. 2018

Brand Success in Mexico ¹⁹	Institute of Social Sciences and Administration, Juarez city University, Juarez, City	perspective. Today's advertising and marketing must implement a global strategy to compete in different geographies affecting different cultures. slowdown in new challenges in different situations and in different markets. In other cultures, in addition to replicating this study, advertising campaigns encourage the search and design of methodologies that can measure the impact of each sensation. A conceptual field for researchers and various companies seeking to improve their marketing strategy.	
Sensory marketing- investigating the use of five senses. ²⁰	Dr Rupa Rathee, Assistant Professor, Department of Management Studies, India.Ms Pallavi Rajain	In this paper, the authors introduce the concept of sensory marketing and explore the use of the five senses in the marketing of products or services.	Sensory marketing, five senses, products, influence, consumer behaviour.

¹⁹ Ramos & Vilchis 2019

²⁰ Rajain & Rathee 2017

	Research Scholar, Department of Management Studies, India	Previous literature review was conducted to find out the level of influence that sensations have on consumer decisions and whether their presence actually influences buyers' decisions. Finally, questions have been raised about the ethical use of online sensory marketing using audio.	
Sensory marketing from the perspective of a support tool for building brand value. ²¹	Margareta Nadanyiova, Jana Kliestikova, Juraj Kolencik	This document provides an explanation for sensory marketing, and expectations are the driving force for success. The first impression of the product provides expectations for shape, material, and odour. If these expectations are not met, it means that the expectations do not respond to perception, and consumers are surprised by the disagreement of these sensations. Audio advertising is often considered inappropriate, and experience is negative.	sensory marketing; brand value; consumer; emotions; buying behaviour.

²¹ Nadanyiova et al. 2018

		These sensory discrepancies also affect brand valuation. Consumer brand awareness is based on interaction with the brands mentioned.	
Sounds Like Chicken :Sensory Marketing and Sound Effects ²²	<p>Joanne P.S. Yeoh</p> <p>Professor, Marketing Department, Saint Joseph's University Philadelphia, United States</p> <p>David Allan</p> <p>Associate Professor, Music Department, Faculty of Human Ecology, Universiti Putra Malaysia, Serdang, Malaysia</p>	The results show that sound effects have a greater impact on consumer confidence and purchases than music and silence. This survey fills the gap whether advertisers will use sound effects, music, or silence.	Advertising, Music, Sensory Marketing, Silence, Sound Effects
Sensory Marketing in Light of New Technologies ²³	Association for Computing Machinery New York, NY, United States	With the explosive growth of online shopping and the growth of e-commerce in	Sensory Marketing, Digital Marketing, Multisensory,

²² Yeoh & Allan 2020

²³ Petit et al. n.d.

		3D virtual environments, the use and understanding of digitally sensitive interfaces of consumers' virtual experiences constitute a promising field for future research. This article introduces reflective methods for the role of new technologies in improving the online consumer experience and how they can help gather consumer multisensory information to provide a defined multisensory experience.	Consumer Neuroscience, Digital Technologies
The Benefits and Effective Application of Audio in Direct Marketing on the Internet. ²⁴	William Perttula PhD Business at San Francisco State University. Mahmood Hussain PhD College of Business at San Francisco State University ,	This article mainly describes the benefits of using voice over the Internet. Marketers have begun to consider current audio as a tool to add value to their websites and promote their brand. These recommendations form a set of viable strategies for direct marketing, as well as a set of testable hypotheses	Internet, Interactive, Direct Marketing, Audio.

²⁴ M. Hussain & Perttula 2006

		for academia researchers.	
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Source: Authors Own

4. Research Results

In this section, we will see how we extracted the audio data from the videos (advertisements) and how the analytical process is done after extracting audio²⁵ data.

In the advertisements, you can hear the heavy breathing of the person in the energy drink ads which indicates that he or she is tired or needs an energy drink.

To understand these sounds in the audio, audio analysis is performed.²⁶ With these analyses, we are able to hear the sounds better and this can be useful for marketing our products.

4.1 Process of extraction of Audio data:

Our project focuses on sensory audio data analysis, so we extracted the audio data²⁷ from the advertisement videos.

Steps involved in extracting audio data are as follows:

1. Launch Mojavi Video Editor, click Media at the top, and select Convert/Save.
2. You'll see a box on your screen. In this box, click Add, and add the video that you want to extract the audio from. Then, hit Convert/Save.
3. On the resulting screen, choose Audio - WAV from the Profile dropdown menu. This will convert your video to a wav audio file.
4. When you're back to the main box, click Browse next to the Destination file and choose the folder to save your audio file in. Make sure to add .wav after your file name if you've chosen the WAV format.
5. Click Start and software will begin to extract the audio from your video.

²⁵ Stowell et al. 2015

²⁶ Säger et al. 2018

²⁷ Salamon et al. 2014

4.2 Process of Audio analysis

4.2.1 Using Amazon Transcribe

Amazon Transcribe provides high-quality and affordable speech-to-text transcription for a wide range of use cases.

1. Go to AWS Management Console then load audio files/data for analysis in S3(Simple Storage Service).
2. Create a bucket in S3 where all the audio input files are uploaded for further analysis.
3. Next amazon transcript service is used where a transcript is created to analyze the input audio.
4. Now a transcript job is created under media content search and monetization which uses amazon elastic search or amazon Kendra to index and search across the uploaded audio library.
5. Further the job is provided a name model type is specified transcription language is set.
6. Now the input data is navigated by browsing through the S3 bucket and selecting the file that needs to be transcribed.
7. Then the job is created.
8. Amazon transcript now processes the audio file and provides the transcript of the audio data.
9. Once Complete the created job can now be downloaded as a JSON file for further analysis.

4.2.2 Using the Python Code

To analyze the audio further in terms of amplitude, waveform, and Spectrogram a python code is written using Google colab.

Google Colaboratory or Colab

An online platform based on Jupyter Notebook that is used to write and execute Python²⁸ code. It requires no additional set-up as it is cloud based and provides free access to computing resources including GPU's.

1. Reading Audio Files
2. Fourier Transform (FT)
3. Fast Fourier Transform (FFT)
4. Spectrogram

1. Reading Audio Files:

Libraries used for reading and analysing the audio data are:

Pandas

Pandas is a library with data manipulation tools that are built on top of and add to those of the established NumPy library.

NumPy

NumPy is a part of a set of Python libraries that are used for scientific computing due to its efficient data analysis capabilities.

Librosa

Librosa is a python library with almost every utility we might need while working with audio data.

Features of librosa

- Loading and displaying characteristics of an audio file.
- Spectral representations
- Feature extraction and Manipulation
- Time-Frequency conversions
- Temporal Segmentation
- Sequential Modelling

²⁸ Giannakopoulos 2015

Loading Audio into Python

Librosa supports almost all the audio code files. After installing the librosa into jupyter notebook/google colab we can load the audio file by using the command line `librosa.load()`

The `librosa.load()` function returns two results - 1. The array of amplitudes. 2. Sample rate.

During recording, the sampling rate refers to the 'sampling frequency'.

If you keep the argument `sr = None`, it will load your audio file at its original sampling rate.

Figure 2: Loading Librosa Library

```
In [3]: file = 'C:/Users/Ankita/Max.wav'

In [10]: samples, samples_rate = librosa.load(file, sr = None, mono = True, offset = 0.0, duration = None)

In [6]: len(samples), samples_rate

Out[6]: (2170368, 44100)
```

Source: Authors Own

The sample rate 44100 shows that the audio is recorded at the sampling rate of 44100. This file is captured 44100 amplitudes per second while recording. For e.g., if we want to know how long an audio file is we can divide the number of samples by its sampling rates as shown below.

Figure 3: Extracting sample audio length

```
duration_of_sound = len(samples)/samples_rate
print(duration_of_sound, "seconds")

49.21469387755102 seconds
```

Source: Authors Own

Figure 4: Importing Audio

```
from IPython.display import Audio
```

```
Audio(file)
```



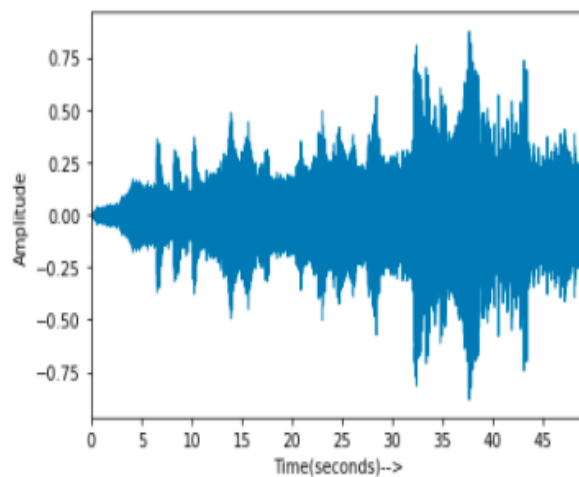
Source: Authors Own

Visualizing Audio

This visualization is called time-domain representation in a given signal. It shows the loudness (amplitude) of sound waves changing with time. When amplitude = 0 it represents the silence. The amplitude is not very informative since it only shows how loud the audio/recording is.

Figure 5: Plotting graph with Amplitude against Time(Seconds)

```
plt.figure()
librosa.display.waveplot(y=samples, sr = samples_rate)
plt.xlabel("Time(seconds)-->")
plt.ylabel("Amplitude")
plt.show()
```



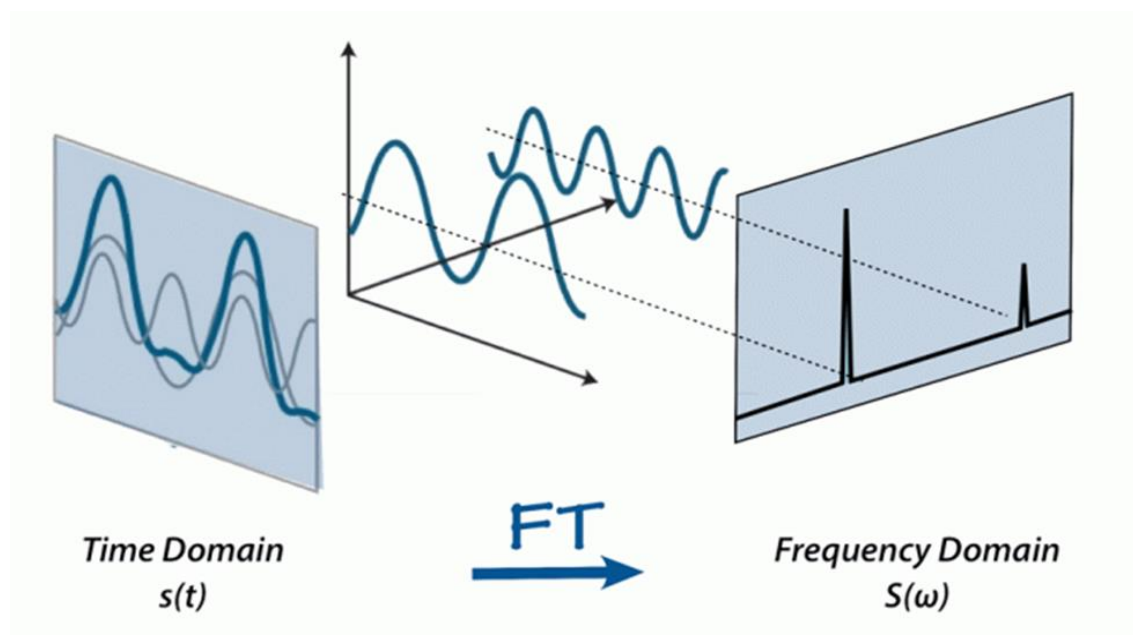
Source: Authors Own

To understand it better it has to be converted into the frequency domain. The frequency-domain represents the frequencies present in the audio/recording. Fourier transforms are used mathematically to convert time-domain signals into the frequency domain.

2. Fourier Transform (FT)

Audio signals are complex signals which are made up of several single-frequency sound waves that travel together as a disturbance (pressure change) in the medium. The resultant amplitudes of the multiple sound waves are captured when the sound is recorded. Fourier Transform (FT) is a mathematical concept/method that can decompose a single sound wave into its component frequencies. In addition to providing two vectors for each frequency present in the single wave, the Fourier transform also shows the magnitude information of each frequency.

Figure 6: Fourier transform



Source: Understanding Audio data, Fourier Transform, FFT and Spectrogram features for a Speech Recognition System - Drops of AI n.d.

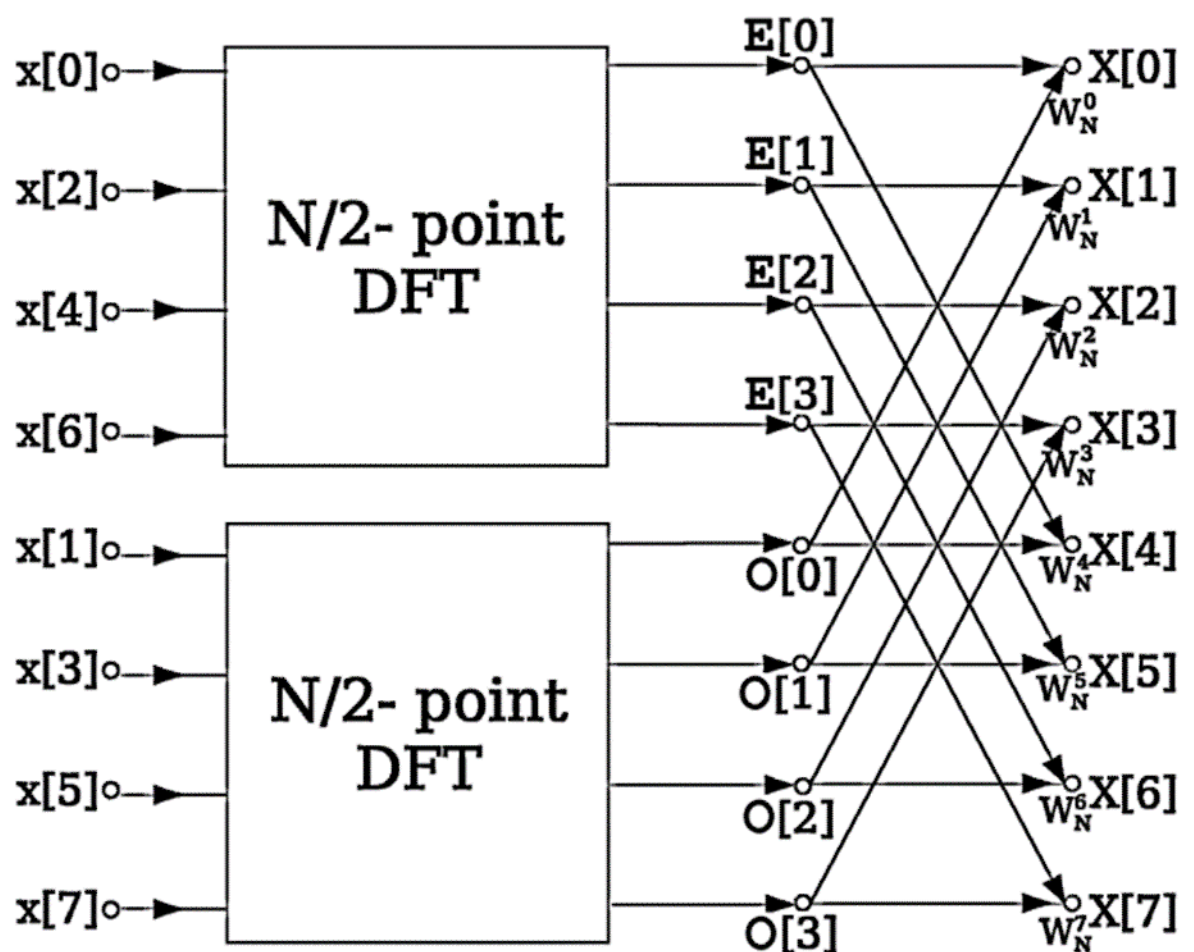
Inverse Fourier transform is the opposite of the Fourier transform. It takes the frequency domain as input and mathematically recreates the original signals.

3. Fast Fourier Transform (FFT)

Fast Fourier transformation (FFT) is a mathematical algorithm used for calculating the Discrete Fourier Transformation (DFT) of the given sequence. Fourier Transform FT) and Fast Fourier Transform (FFT) are different only because Fourier Transform accepts

the continuous signals and Fast Fourier Transform accepts the discrete signals. Like Fourier Transform (FT) accepts continuous signals the Discrete Fourier Transform (DFT) measures a sequence a bit (discrete signals) in a frequency component. The amplitudes in our data are the samples of continuous audio signals. These discrete time-domain signals can be converted into the frequency domain using DFT or FFT algorithms.

Figure 7: FFT Algorithm Overview



Source: Understanding Audio data, Fourier Transform, FFT and Spectrogram features for a Speech Recognition System - Drops of AI n.d.

Simple Sine Wave to Understand FFT

To understand the output of FFT, let's create a simple sine wave. This code creates a sine wave with the following parameters: sampling rate = 100, amplitude = 1, and

frequency = 3. Each amplitude value is calculated every 1/100th second (sampling rate) and a list called y1 is created. Using the FFT algorithm, we will calculate the DFT of this signal based on the discrete amplitude values.

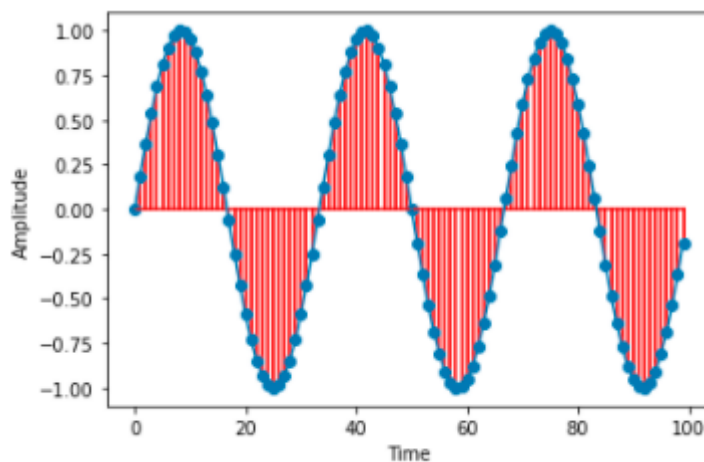
Figure 8: Interpreting the sample in Waveform

```
samples = 100
f = 3
x = np.arange(samples)
y1 = np.sin(2*np.pi*f*(x/samples) )
plt.figure()
plt.stem(x,y1, 'r', )
plt.plot(x,y1)
plt.xlabel("Time")
plt.ylabel("Amplitude")
plt.show()
```

Source: Authors Own.

As shown in the following screenshot, plotting these discrete values (y1) with sample number on the x-axis and amplitude on the y-axis results in a nice sine wave plot.

Figure 9: Sine graph of Amplitude vs Time



Source: Authors Own

In list y1, we now have a series of amplitudes. Using SciPy, we will pass this sequence to the FFT algorithm. The algorithm returns a list of complex-valued amplitudes of the frequencies found in the signals. The positive frequency terms appear on half of the list, while the negative frequency terms appear on another half of the list. To determine the frequencies in a signal we have to choose any half and calculate its absolute value.

Let's make another sine wave to examine the FFT output for signals that have more than one frequency. As before, we will keep sample rate = 100, amplitude = 2 and frequency = 11. The following code generates this signal and plots the sine wave.

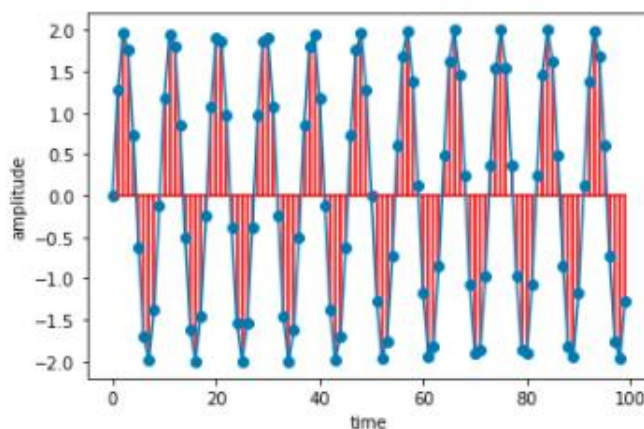
Figure 10: Interpretation of Time vs Amplitude with frequency at 11.

```
In [34]: samples = 100
         f = 11
         x = np.arange(samples)
         y2 = 2 * np.sin(2*np.pi*f*(x/samples))
         plt.figure()
         plt.stem(x,y2, 'r', )
         plt.plot(x, y2)
         plt.xlabel("time")
         plt.ylabel("amplitude")
         plt.show()
```

Source: Authors Own

As shown in the below graph, a sine wave is generated. If we had increased the sampling rate, it would have been smoother. Because we will later combine this signal with our sine wave, we kept the sampling rate at 100.

Figure 11: Sine Wave of Time vs Amplitude at 11 frequencies



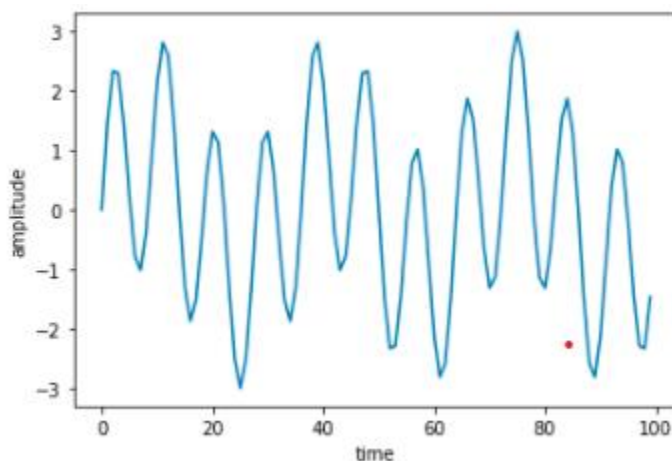
Source: Authors Own

Assuming this wave is also an FFT, we will see the same spike at frequency 11. As a result, we are interested in the outcome of adding these signals of the same sampling rate but different frequencies and amplitude values. Here sequence y_3 will represent the resultant signal.

Figure 12: Combining the outputs

```
y3 = y1+y2
plt.plot(y3)
plt.xlabel("time")
plt.ylabel("amplitude")
plt.show()
```

If we plot the signal y_3 , it looks something like the figure below.

Figure 13: Plotting the output.

Source: Authors Own

4. Spectrogram

You may recall that in the previous exercise, we divided our signal into its frequency values, which will serve as features for our recognition system. We lost track of time information when we applied FFT to our signal since it only gave us frequency values. If we use these frequencies as features, our system won't be able to analyse the audio properly. Our system needs a different method of calculating features so that it has the time at which the features were observed as well as the frequency values. Spectrograms play an important role here.

A spectrogram is a visual representation of frequencies over time of a signal. A spectrogram plots frequency versus time. At significant points in time, the magnitude (amplitude) of the data is represented with colours. The following screenshot shows the spectrogram for the same audio file we discussed earlier. Strong frequencies are

represented by bright colours. Similarly, to the earlier FFT plot, the smaller frequencies (0-1kHz) are brighter(strong).

Figure 14: Code for Fourier Transform

```
filepath = 'C:/Users/Ankita/Max.wav'

""" short time fourier transform of audio signal """
def stft(sig, frameSize, overlapFac=0.5, window=np.hanning):
    win = window(frameSize)
    hopSize = int(frameSize - np.floor(overlapFac * frameSize))

    # zeros at beginning (thus center of 1st window should be for sample nr. 0)
    samples = np.append(np.zeros(int(np.floor(frameSize/2.0))), sig)
    # cols for windowing
    cols = np.ceil((len(samples) - frameSize) / float(hopSize)) + 1
    # zeros at end (thus samples can be fully covered by frames)
    samples = np.append(samples, np.zeros(frameSize))

    frames = stride_tricks.as_strided(samples, shape=(int(cols), frameSize), strides=(samples.strides[0]*hopSize, samples.strides[0]),
    frames *= win

    return np.fft.rfft(frames)
```

Source: Authors Own

Figure 15: Code for Scale Frequency

```
""" scale frequency axis logarithmically """
def logscale_spec(spec, sr=44100, factor=20.):
    timebins, freqbins = np.shape(spec)

    scale = np.linspace(0, 1, freqbins) ** factor
    scale *= (freqbins-1)/max(scale)
    scale = np.unique(np.round(scale))

    # create spectrogram with new freq bins
    newspec = np.complex128(np.zeros([timebins, len(scale)]))
    for i in range(0, len(scale)):
        if i == len(scale)-1:
            newspec[:,i] = np.sum(spec[:,int(scale[i]):], axis=1)
        else:
            newspec[:,i] = np.sum(spec[:,int(scale[i]):int(scale[i+1])], axis=1)

    # list center freq of bins
    allfreqs = np.abs(np.fft.fftfreq(freqbins*2, 1./sr)[:freqbins+1])
    freqs = []
    for i in range(0, len(scale)):
        if i == len(scale)-1:
            freqs += [np.mean(allfreqs[int(scale[i]):])]
        else:
            freqs += [np.mean(allfreqs[int(scale[i]):int(scale[i+1])])]

    return newspec, freqs
```

Source: Authors Own

Figure 16: Code for Spectrogram

```

""" plot spectrogram """
def plotstft(audiopath, binsize=2**10, plotpath=None, colormap="jet"):
    samplerate, samples = wav.read(audiopath)

    s = stft(samples, binsize)

    sshow, freq = logscale_spec(s, factor=1.0, sr=samplerate)

    ims = 20.*np.log10(np.abs(sshow)/10e-6) # amplitude to decibel

    timebins, freqbins = np.shape(ims)

    print("timebins: ", timebins)
    print("freqbins: ", freqbins)

    plt.figure(figsize=(15, 7.5))
    plt.imshow(np.transpose(ims), origin="lower", aspect="auto", cmap=colormap, interpolation="none")
    plt.colorbar()

    plt.xlabel("time (s)")
    plt.ylabel("frequency (hz)")
    plt.xlim([0, timebins-1])
    plt.ylim([0, freqbins])

    xlocs = np.float32(np.linspace(0, timebins-1, 5))
    plt.xticks(xlocs, ["%.02f" % l for l in ((xlocs*len(samples)/timebins)+(0.5*binsize))/samplerate])
    ylocs = np.int16(np.round(np.linspace(0, freqbins-1, 10)))
    plt.yticks(ylocs, ["%.02f" % freq[i] for i in ylocs])

    if plotpath:
        plt.savefig(plotpath, bbox_inches="tight")
    else:
        plt.show()

```

Source: Authors Own

Figure 17: Plotting the Spectrogram

```

if plotpath:
    plt.savefig(plotpath, bbox_inches="tight")
else:
    plt.show()

plt.clf()

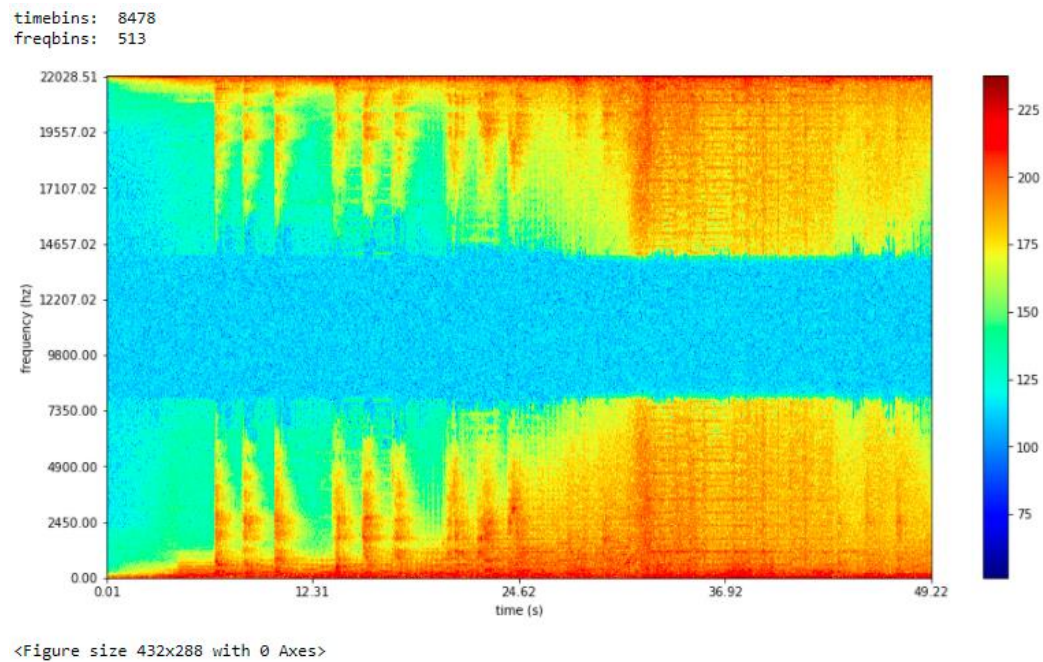
return ims

ims = plotstft(filepath)

```

Source: Authors Own

Figure 18: Visuals of Spectrogram with frequency vs. time



Source: Authors Own

5. Projection of Results

By analyzing the audio in Amazon Transcribed, we can get the transcript of the audio. Furthermore, this transcript can be used to do text analysis to gain a better understanding of the audio data from a sensory marketing perspective. Using Python code, the audio analysis is also performed. The outputs of this analysis are the Waveforms and Spectrogram. On Waveform, audio files are categorized according to their amplitudes. For e.g., in the Air pods advertisement, the different sound frequencies are used to show how different frequencies can help to make a better music experience. As an example, the different sound frequencies used in the Air pods advertisement show how different sound frequencies can enhance your music listening experience. Spectrograms represent acoustic signals visually. A spectrogram is a tool for representing audio in terms of hertz and amplitude. Spectrograms show the effect of different amplitudes on human beings. E.g., If soft music is playing in a shop, customers want to stay and shop, but if the music is too loud, customers won't want to stay or shop.

5.1 Limitations:

Although we cannot achieve anything without facing any challenge but there are some limitations which we encounter during our research and that limit us for further processing. Some of the limitations are:

- No free software is available in the cloud as well as a standalone product for sound classification.
- System infrastructure for audio analysis is expensive in the cloud as well as in local system
- Setup a Local coding environment is challenging.
- No functional workaround is available to extract background or ambient sounds to analyze the audio clip.

6. Conclusion and Outlook

According to the present research, we found that there are lots of frequencies that represent an audio signal. We can understand and modify those signals using the sampling rate or Nyquist theorem. (More to explore)

After analyzing different audio signals integrated into a signal audio stream which directly hit user's senses and make them rethink and change their decision towards brands.

In the future, we want to dig deeper and explore these audio signals used by different organizations and how they help them in terms of popularity and market growth.

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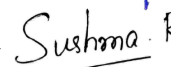
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Essen, 26.08.2021

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