The Vocaloid Phenomenon: Deconstruction of Music Culture Through Hatsune Miku

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The emergence of Hatsune Miku, a Japanese-developed virtual singer characterized by the artificial voice synthesis software by Crypton Future Media, has symbolized a pivotal shift in the music industry, characterized by the deconstruction of popular culture for individualism in musical expression. Through a quantitative review of the American, Japanese, and Vocaloid music charts, this study addresses the implications of grassroots movements and industrial practices on lyric writing, social structures within the scene, and music production. By contrasting these expressions, the study discovers a participatory community and increasing accessibility through open-sourced technology have allowed digital platforms to diverge from the music industry and isolate cultural expression from society.

Introduction

Previous research indicates the process of democratization through digital participatory networks can be epitomized in a case study when Crypton Future Media, a Japanese media company, distributed the virtual singer Hatsune Miku in August 2007[1,2,3]. Miku functions as a VOCALOID, a mass-produced software that concatenates vocal fragments from a pre-recorded library of voice samples, artificially manipulating the human voice at a user's artistic discretion. Alongside its release, the character Hatsune Miku came to visually represent the voicebank as a human singer[2,4]. The program catalyzed the amateur music scene, attempting to cooperate with a consumer base "who had been alienated from the production path of mainstream commercial media"[3]. Creators utilized online platforms to collaborate in mixed media content, cultivating a grassroots movement characterized by the evolving ecology of software technicians, producers, and audience members collaborating to make Vocaloid music[5,6,7]. As a result, the years after her initial release yielded hundreds of thousands of subsequent fan contributions, extending her voice and character from original music to live concerts, collaborative projects, and video games[7,8,5]. This rapid proliferation of content has shifted the traditional norm of consumption and production, emphasizing the "inherent role of potential participants in these processes as active users of content" rather than passive consumers[3]. As a result, the era of globalization and Internet culture has realized a growing recognition of the consumer's influence in shaping their cultural identity and defining their social networks[9].

Gap in Research

Although previous researchers emphasize the value of Hatsune Miku's cultural impact within Japan (eg.,[3,7], the past decade has generated comparatively little data, and the focus on amateur production inhibits her exposure to other music industries, retaining the Vocaloid phenomenon within Japan. Additionally, because research largely centers around her anthropological existence and participatory culture on social media[8,4,10], the literature surrounding the Vocaloid phenomenon should consider the ramifications of the cultural shift in music from a societal and unifying experience to an individual reflection of human life. In evaluating these characteristics, this analysis exemplifies the significance of music hybridity on globalized diffusion and shifting interpretations of social identity. Therefore, given the implications of participatory culture in an increasingly globalizing digital society, it is critical to ask: to what extent has integrating Hatsune Miku into the digital music scene facilitated a deconstruction of culture and society?

Literature Review

This literature collection will focus on the alienation of culture from immediate systemic structures such as political ideology, economic pursuits, or social issues and its impact on interpersonal communication and musical trends.

Technological Advances and Future Considerations

Knight and her colleagues in Media Convergence in Japan[11] also suggest that VOCALOID reflects a new form of media

production, combining grassroots culture with corporate sponsorship. As a hybrid creative economy, fan creations rely on corporate power for international recognition as Crypton curbs expenditures by commissioning prevalent fan contributions instead of songs from established professionals[11,6]. Unlike traditional celebrities, where the "media plays a vital part to every existence"[12], Miku represents a futuristic shift in media representation, where her networked audience has deliberate creative control over her reputation[11]. Furthermore, a closer inspection of these assumptions also suggests that Hatsune Miku operates as several infrastructures integrated into the digital network; the stabilized core, though figurative, emphasizes the congregation around social identity. Therefore, another critical distinction arises. As an empty shell, Miku's existence is "an enrollment of things: extensible, incomplete, and commodious–in short, an assemblage," states Nick Prior in Rethinking Music through Science and Technology Studies[5]. Miku's assemblage nature continues solely on the whims of her audience, intensifying the importance of maintaining music hybridity and creative independence to sustain global accessibility. While Knight and her colleagues examine the rise in popularity from an economic and business standpoint, their perspectives fail to consider the malleable characteristics of virtual identity, emphasized by Prior, who suggests that self-expression is the foundation for the creative ecosystem that Cyrpton builds itself on.

Online Communities and Societal Impact

Because open expression was the basis for the Vocaloid scene, the virtual phenomena also manifested new forms of social interaction. For instance, Kit Yan To (2014), holding a Master's in Music from the University of Texas at Austin, depicts the Vocaloid community as a web of interpersonal relationships that increases affordability and access to music production. His thesis reviews VOCALOID producers, emphasizing that the open nature of copyright instigates subsequent creations through the Actor-Network theory (ANT); as interpersonal relationships diverge, more producers contribute to the online culture, influencing other individuals[2]. Similarly, in a case study published by the International Society of Markets and Development, Hajime Kobayashi and Takashi Taguchi (2018) identify two network effects where the expansion of creative content and user participation reinforce each other and create a positive feedback loop (Figure 1).

Although these perspectives demonstrate social changes within the VOCALOID community, Dr. Rafal Zaborowski, with an MA in Media and Cultural Studies from Tohoku University, suggests that Miku's crowdsourced existence allows the audience to interpret a sense of emotional authenticity through participatory culture through his fieldwork in Japan. As Vocaloid producers circulate their messages and values,

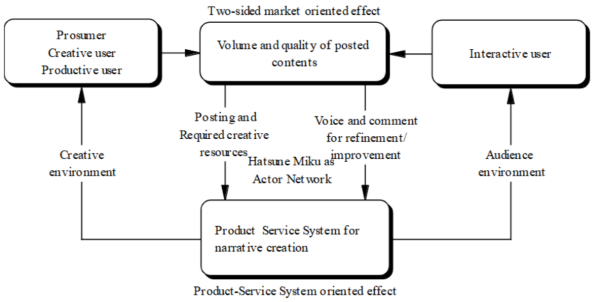

Fig. 1 Two Network Effects that Created the Hatsune Miku Phenomenon[13].

the Internet audience empathizes and becomes active creators, formulating a unique digital culture that diminishes the separation between the performer and the audience[7,4]. The cumulation of their research exemplifies that VOCALOID production insinuates the audience to actively shape Miku's persona through the 'circuit of culture,' where meaning is constantly reconstructed and deconstructed by the interaction of various producers and ideas[7].

Vocaloid and Cultural Influence

It is crucial to qualify the significance of Miku's abstract existence in deconstructing culture. Associate Professor in Film Studies Sandra Annett (2015) proposes that the Vocaloid phenomenon is a movement to deconstruct desire, or the force of creative production, and how it is restrained or stratified. In her interdisciplinary study, Annett (2015) regards Hatsune Miku as emblematic of "surfaces that facilitate the play of desire" instead of "rounded subjects created to express one vision," like traditional characters (p. 169). Associate Professor in the field of Science and Technology Dr. Annise Lam's (2016) case study, for instance, acknowledges this thesis through a case study on Vocaloid productions, suggesting these producers "continuously impose their own values and perceptions" to compensate Miku's lacking depth (p.1111). Furthermore, an interpretive approach to the Vocaloid phenomenon demonstrates that as an "artificial time-based product" with isolated elements digitized on the internet lacking a historical narrative, Miku challenges traditional concepts of life in celebrity culture[14]. She pivots Vocaloid audiences to consume music for the quantity of experience, constructing a superficial understanding of various identities behind her songs[14]. While these researchers epitomize Hatsune Miku's digital nature, Yiyi Yin (2018) of Beijing University's School of Arts & Communication summarizes the cultural implications of the developing music field. Her case study of Vocaloids in China proposes the accessibility of the digital space exposed user-generated content to various regions, increasing the complexity of diverse social identities. Exposure to local and global music causes

VOCALOID prosumers to identify in diverse social positions, complicating the interconnected nature of social identities rather than reflecting distinguishable, bicultural personas[9]. Through a parallel analysis of Miku's virtual nature, these researchers emphasize that her malleable characteristics and influence on global networks reflect transforming definitions of social identity.

Conclusion

Various studies exemplify the interplay between Vocaloid technology and the internet incited the deconstruction of identity[15]. However, these studies have yet to address if the logistics of music production have experienced changes as a result. This study determined the extent to which Hatsune Miku has deconstructed cultural and industry norms to assess the practicality of the literature review.

Methods

Although the foundation of traditional social identities was once largely dependent on the immediate environment's political and societal structures, the rapid globalization of music, particularly in the Vocaloid climate, has aligned audience-turned-producers with "the communication, exchange, and collaboration of everyday life"[10].

Given the introduction of "dynamic subjectivity, struggling in paradoxes between self-expression and dominant power" within the Vocaloid scene[9], the study's focus is the significance of a digital climate in developing culture through music collaboration and production. The goal is to increase awareness of consequential societal trends from a rapidly globalized network. The method of inquiry is a three-part, quantitative-based comparative analysis of popular Japanese and American songs on the year-end Billboard charts and the Vocaloid Collection. Because the approach evaluated qualitative data, such as song lyrics, through a numerical system, the study measured discrepancies that a qualitative-based method would overlook[9]. Additionally, the procedure minimized bias by including a diverse music dataset and replicated a case study consistently across three environments. The findings were graphed. The three-part approach measured the statistical significance of the discrepancies, observed distinct trends, and evaluated the accessibility of these environments. Combining a qualitative approach and quantitative data provided a holistic overview of the dissimilarities and their consequences on cultural development between traditional industries and the digital climate.

Design

A cross-comparative examination of Japan and America's Billboard Year-End charts and the Vocaloid Collection rankings generated a diverse dataset for the research design. The study examined whether music deviating from individual backgrounds is more prevalent in the Vocaloid online environment or music industry. The Billboard Year-End charts for the Japanese

and American industries were selected for their ranking of the 100 most popular annual songs, or a representation of mainstream music trends over time. The Vocaloid Collection, which ranks the top 100 songs biannually, was utilized as it was the only available chart providing a consistent sample for Vocaloid songs. Therefore, the sample size consisted of 100 songs annually for seven years across the three groups, totaling 2,100 songs. A random number generator was used to list ten distinct numbers from 1 to 100, and the corresponding songs were selected for data collection. The trends in these percentages studied were triangulated to evaluate whether Vocaloid's creative climate has augmented "playfulness" within an artistic craft.[16]. As seen in the literature review, past researchers conducted case studies concerning societal collaboration within the Vocaloid scene; however, the research did not correlate the trends with a transition in songwriting as a reflection of culture. Pre-existing research also demonstrates no evidence of a comparative analysis between different music industries. Therefore, the research design depicted the influence of the environment between locations, emphasizing the extent to which these factors have played a role in music production. Together with the findings, the methods illustrated whether the internet integration into music through Hatsune Miku has impacted the development of our culture.

Variables

The independent variable, "music environment,"is operationalized through its categorization into three distinct groups: the J-pop industry, which exemplifies a traditional industrial model; the Billboard rankings, which represent a structured, mainstream approach in a different cultural context; and the Vocaloid rankings, which signify a digital, internet-based

environment. By keeping consistency across the years and charts, the research measured the impact different circumstances have on music production, collaboration between artists, and the degree to which immediate cultural norms influence the songs. Variations in production setting— from traditional industry models, such as the J-pop and Billboard charts, to internet-driven platforms, like Vocaloid determined the measurement criteria for the independent variable. The method categorized the dependent variables into three subsections: music trends, differences in collaboration, and lyrical coding. From a music standpoint, the study documented the song length (secs.),

length until chorus (secs.), the percentage of the chorus in the lyrics, tempo (bpm.), and song structure (see Appendix B). The differences in collaboration included whether the song was commissioned, the number of producers and songwriters, established artists with a previous charting song, and rising artists without a precursory chart rank (See Appendix C). Lyrical coding generated percentages of lyrics that exhibited the following categories: individual voices, cultural motifs, current societal trends, personal pronouns, pronouns referencing other individuals, and theme (See Appendix A).

Procedure

The study collected data from twenty-one simple random samples of ten songs from each year-end chart from 2016 to 2022. Seven samples for each industry were further blocked, creating three sets of seventy songs. Music without a chorus or with unavailable lyrics received the detonation 'NA' or a zero for the percentage of the chorus—the extracted data graphed trends to understand the extent of conformity within musical boundaries. These elements were documented to analyze the deviation from typical song formats across the music environments. The study additionally quantified the number of collaborators on a song. Collaboration data and music trends assisted in rationalizing the variance of producers between industries.

The dependent variable subcategory addressed how music environments affect the involvement of multiple creators and the likelihood of new artists emerging in each setting. Lyrical analysis measured the proportional relationship between the number of lines associated with the category and total quantity of lyrics. For the individual voice and cultural motif categories, individual experiences were defined as personal experiences or rhetorical questions unable to extrapolate on a societal scale. At the same time, lyrics influenced by society contained distinct references to a cultural standard. Lyrical coding aimed to quantify the extent to which songs from different environments reflect personal versus societal themes and cultural influences, allowing for an examination of the influence of the music environment through lyrical content. The Institutional Review Board (IRB) approved the procedures to eliminate ethical issues.

Findings

The study determined a linear relationship because the residual plots illustrated a random association and approximately equal distribution of positive and negative residuals (Appendix D). The correlation coefficient, or R2 value demonstrating a sample's association to predictable linear relationship, was 0.076, 0.128, and 0.401 for Japan, America, and Vocaloid songs (Figure 2). Although higher coefficients illustrated conformity to musical norms through the dataset's adherence to a linear pattern relative to other datasets, Vocaloid illustrated a moderate correlation; the American industry exhibited weak adherence to observed patterns and Japanese songs had an insignificant relationship. This finding aligns with the observed patterns: Vocaloid songs displayed fewer outliers, all songs illustrated a positive correlation between melodies and length until chorus, and Japanese songs demonstrated a more varied spread and multiple outliers.

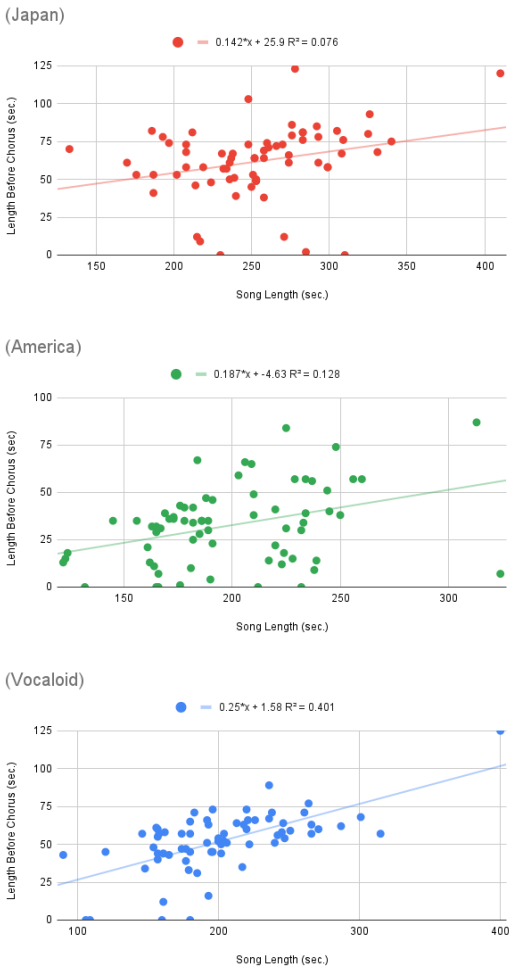

Fig. 2 Linear relationships between song length and time before chorus for Japan, America, and Vocaloid, respectively (Appendix B).

Similarly, the Vocaloid environment demonstrated elevated adherence to music trends during the seven years compared to other environments. While the individual Vocaloid songs centered on a trendline (Figure 2) and the percentage of the chorus also experienced a positive linear association, American and Japanese music saw a decline and weaker correlations over time (Figure 3). The correlation coefficient was 0.026, 0.147, and 0.279 for Japan, America, and Vocaloid. Furthermore, the results directly contradict the deconstruction of culture and the

rise of individualism in the literature review findings.

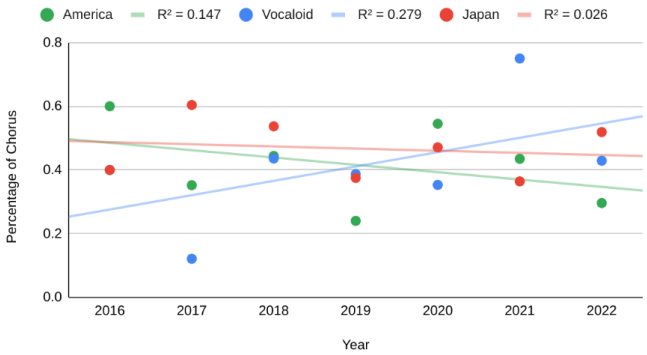

Fig. 3 The average percentage of chorus for each environment by year (Appendix B).

Differences in Collaboration

A distinction emerges in the type of participants involved in the songwriting or producing process: the proportion of rising to established artists was 3.68 times greater in Vocaloid compared to 0.27 and 0.17 for American and Japanese industries; established Vocaloid artists ranged from 0.1 to 0.7, established American artists ranged from 3.3 to 4.7, and established Japanese artists ranged from 0.9 to 2.3 (Figure 4). Therefore, the conformity in musical statures (Figure 2) corresponds to the transition to amateur artists in the Vocaloid scene.

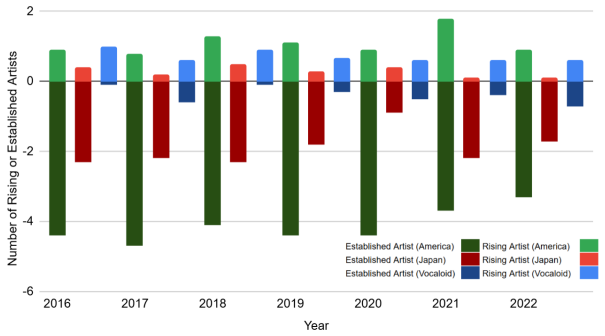

Fig. 4 The average number of established and rising artists in one song each year by environment (Appendix C).

Lyrical Coding

The study considered distinctions in songwriting to discern if the rise of amateur artists and unique collaboration patterns would deconstruct cultural norms through spoken word. Figure 5 represents the themes in each environment. Similar to the differences between rising American and Japanese artists and rising Vocaloid artists, the quantity of themes varies depending on the environment. Whereas the Vocaloid sample exhibited a 33% increase from Japan in the number of themes, the sample also demonstrated a 53.85% increase compared to the American industry.

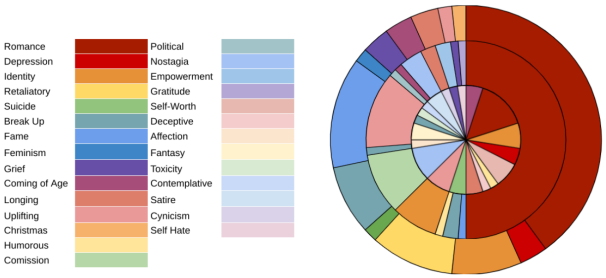

Fig. 5 Quantities of themes across Billboard America, Billboard Japan, and the Vocaloid Collection.
Note. The outermost ring represents the Billboard Year-Charts for America, the center is the Japanese industry, and the innermost circle is the Vocaloid Collection.

Vocaloid songs also ranked significantly higher in individual voice than the other music industries while maintaining low scores in political lyrics. In contrast, American and Japanese pieces rated similarly for political lines while having varying scores for the individual voice category.

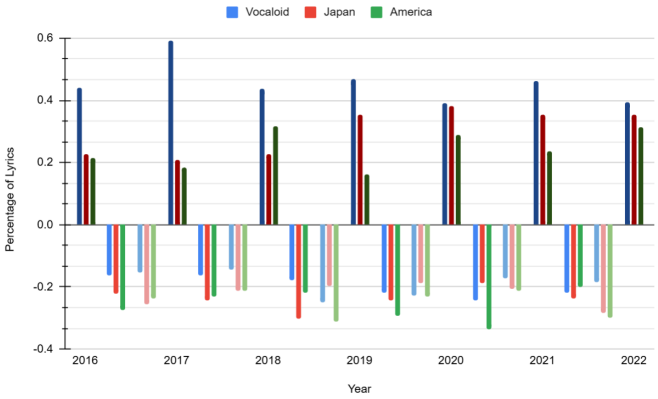

Fig. 6 The percentage of lyrics containing individual voices, political motifs, or current events (respectively) for each year (Appendix A).
Note. The median value of 'individual voice' is considered positive and shaded the darkest. Political motifs and societal events were negative and shaded lighter, respectively. The chart blocked data by category to compare each environment separated by color.

Analysis

The study aimed to demonstrate how the development of grassroots movements through the intersection of technology,

Hatsune Miku, and the internet would alter compared to traditional industries, particularly in the music they produced.

0.1 Musical Development

Although Hatsune Miku is an open-sourced figure with deliberate creative control provided to the audience, Vocaloid producers demonstrated compliance with a distinct positive correlation between song length and the length until the chorus and minimal outliers (Figure 2). Limited music development over the seven years further illustrates little musical experimentation compared to its industrial counterparts (Figure 3). The Vocaloid series exhibits

a relative increased reception to repetitive choruses with the highest correlation coefficient. In contrast, the relationship for American and Japanese industries, with correlation coefficients less than 0.3, are considered negligible. One theory by Kyle Davidson (2017), a Doctor of Philosophy from the University of Tartu's Institute of Philosophy and Semiotics, exemplifies that play, or nonverbal forms of creativity and individuality, originate from the verbal language system. Therefore, "the verbal takes priority and enables the play to occur," facilitating a creative image of Hatsune Miku's sound to the audience[16]. Despite the Vocaloid's scene favoritism towards popular music structures, this trend also signifies a communal depreciation of music quality for quantity. The accumulation of these factors transforms Miku into an entity of mass public veneration and public access to inexperienced artists, contributing to a community driven by a 'quantity over quality' mindset and an oversaturation of musical norms[8]. With its low entry barrier, Vocaloid's digital ecosystem heavily relies on the platforms' algorithms and audience participation. Although the product requires professional skill to produce high-quality music, the software's appeal to amateurs with a rudimentary proficiency in music "facilitated grassroots productions" within the Vocaloid scene instead[9]. Vocaloid artists also often reuse components from other pieces to develop their inspired versions, causing the success of certain musical structures to influence an artist's creative decision[1]. The contrast symbolizes the distinctions between quantity and quality attention economies, such as how each environment retains its audience's engagement. In traditional industries, mass media circulation of a celebrity "enables their audience to connect as a community through conversations about them"[12]. The emphasis on celebrities' reputations and past distinctions relies on "stabilizing groups and defining activities" for culture and connectivity to emerge[2]. As a result, the weak correlations between songs exemplify a quality-based approach to centralize public attention on singular actors in industry-based attention economies. While traditional celebrities operate in their quality environment to add economic or cultural value to society[12], Hatsune Miku's body without organ existence drives a quantity-based economy or "a marketization of creativity"[17]. The difference lends the Vocaloid scene to capitalize on a distinctive consumer base: emerging rather than established artists.

Societal Impact

Another difference arises with the configuration of the Vocaloid system. Without the

restriction of culture influencing interpersonal collaboration, the economy revolving around Hatsune Miku becomes a "self-generating network of interactivity"[4]. The marketization of individualism- from a quantitative environment reliant on audience participation- allows rising artists to gain attention. Furthermore, a mass participatory theater and two market effects demonstrate how Hatsune Miku's expansionist nature curates music through the audience-to-producer pipeline (Figure 1). These conclusions exemplify the transition from established to rising artists (Figure 4) facilitates a quantity-based attention economy. The music scene emphasizes an "interaction-oriented account of the collective work," such as clicks or communication strokes, "rather than merely outcomes and products" or page views[3]. In turn, the deconstruction of social collaboration from centralized authority to complex networks is the basis influencing the consumption of musical expression. Given the connections between music trends and social cooperation, considering only one area would have overgeneralized major rationales for cultural deconstruction in Vocaloid.

However, the study also highlights a contradiction. While America scored lower on the metric reflecting personal experiences than Vocaloid music (Figure 6), the highest number of rising artists concentrated in the West (Figure 4). Furthermore, although the data does not demonstrate a positive correlation between new artists and lyrics containing 'individual voice,' individuality is inversely related to collaboration in songwriting and production (Appendix E). One inference is that the pressure of conformity exists in these spheres more significantly than in the Vocaloid scene. Whereas mass media or record companies- singular entities- take precedence in a celebrity's reputation and audience[12], Miku's body without organs allows for a "collaborative effort of many intellects, but also diversified sets of data invested in a joint project"[18]. From a cultural standpoint, traditional economies depend on the "approval of content by gatekeepers or editorial staff"[3], causing established artists to be significantly more common within the American Billboard (Figure 4). Since the difference between the amount of Vocaloid and American artists contributing to a song is statistically significant (Figure 6), the minimal involvement of producers allows "a confluence of the creative energies from countless users" to saturate the scene[10]. In contrast, the proximity of the Vocaloid and Japanese environments, which also often overlap, contributed to their similarities.

Cultural Influence

Unlike its counterparts, the Vocaloid music scene isolates culture from other dominant life systems, such as politics or economics. Producers within "the digitarian community hunt for diversity… to explore new possibilities," transitioning culture from a way of life to a current lifestyle[14]. The results illustrate the emphasis on

diversity through the quantity of thematic content in compositions compared across the three scenes (Figure 6). In conjunction with Isfiaty's research, the discrepancy can be attributed to Vocaloid characters "deliberately designed to be devoid of any apparent cultural specificities"[9]. Zaborowski similarly emphasizes that Vocaloid producers often answer "precisely because the voice is the same, the listener can appreciate the quality of the melody and the lyrics"[7]. Although creating characters as symbols rather than physical beings persisted before digital media, traditional companies often value control over circulation[17]. In Western markets, audience participation is conducted in closed networks and rarely recognized by the companies. Because the industries upheld culture as a dominant structure, the American and Japanese enterprises contained similar thematic entries; societal-focused themes such as romance were significantly more common in these environments (Figure 5). However, the VOCALOID environment presents an alternative circumstance: emotional investment and an audience cause "not only the aesthetic commodities produced in this contact ephemeral and ever-changing but also making the role of the fan uncertain"[17]. The adjusted emotional investment through participatory culture created a platform for individuality-focused songs. In other words, the most substantial contrast between the Vocaloid, American, and Japanese industries is how the environments determine the function of social identities through balancing creativity and control. The distinction between artist and audience

is rarely challenged by collective, participatory arrangements, allowing for absolute authority over production means. The social identities surrounding these industries are rigid. In this context, Vocaloid compositions exist past "being merely the products of intentional and scripted production process"[18].

Despite the Vocaloid community's tendency to challenge traditional structures and prioritize independent social identities, the moderate correlations observed in the data (Figure 6) suggest only a slight association between its lyrical content and a shift toward individualism. Thus, while the Vocaloid scene disrupts conventional frameworks, it is not sufficient to conclude a definitive pivot toward individualism. Such an alternative music economy exemplifies a unique balance between creativity and collaboration, without entirely redefining social identities or cultural dynamics.

Conclusions

The study considered the influence of digitalization on cultural development, societal collaboration, and music production through the body without organ entity, Hatsune Miku. By gathering music from three different environments: the American, Japanese, and Vocaloid scenes, a comparative analysis concluded the open-source technology, Vocaloid, had evolved the Internet into a platform of individuality, exchange, and collaboration, fostering dynamic subjectivity among audience-turned-producers. Although Hatsune Miku and the Vocaloid environment have introduced significant innovations in participatory culture and digital music production, their transformative effect on global music culture may be limited in scale. The participatory framework facilitated by Vocaloid has fostered unique cultural exchanges and creative expressions, but it has minimally disrupted traditional music markets outside these niche spaces (Figure 2; Figure 6;[9]). Through the conducted analysis, the research addressed several gaps in previous research. Pre-existing research considered the implications of social connectivity[2,3]; however, Vocaloid's impact on music was not considered. Furthermore, the literature review did not address the connection between all three subjects: musical standards, social collaboration, and cultural expression. Although some researchers considered the relationship between Vocaloid producers and cultural diffusion, these studies often incorporated qualitative methods or failed to address whether the differences were significant compared to other industries. Therefore, these gaps served as the foundation for the study to gain a holistic understanding of the Vocaloid phenomenon.

Implications

As technology advances, the role of digital platforms in shaping cultural and creative industries will continue to occupy an integral place. Especially with the integration of artificial intelligence, the debate surrounding the extent to which virtual commodities interfere with the creative process persists. To that end, the Vocaloid environment realizes a possible future for technology in our economic, social, and cultural sectors. The music scene "gave rise to the communities of knowledge, interests, and tastes that have in their own terms become a driving force of the participatory culture" as Hatsune Miku promoted the expression of individuality[18]. From another perspective, the Vocaloid phenomenon is the development of rebuilding society and culture centered on a medium rather than a physical environment. A medium, suggested by Thibeault and Matsunobu (2017), is a "larger network that emerges through recurrent use" (p. 1). Miku is contingent; she situates the ecology of her participatory audience to mold the cultural landscape, whereas the Japanese or American industries fluctuate with the socio-economic conditions of their respective countries. As

the study demonstrates, the digitalization of the human voice in music reconstructed Miku's character through the practices of her community, introducing globalization that facilitated "a multidimensional cultural flow on a global scale"[9]. However, the catalyst for the cultural and social deconstruction is not only the universality of Hatsune Miku but also the Internet. The research findings suggest that more prominent accessibility to open-source resources has bridged the separation between producers and consumers of entertainment, where the decreased productivity cost has redefined cultural development in art.

Limitations

Although the findings considered the conditions that allowed for the success of Vocaloid and its grassroots ecosystem, there are still research areas in the development of music, cultural development, and the impact of Vocaloid. For instance, one limitation of this research was the music charts themselves. Globalization in recent years resulted in international music diffusing into the charts, diluting the quantity of producers in the documented environments. Future research could consider the dissemination of these international artists and their implications on cross-cultural pollination.

Similarly, while the research exemplified the decrease in collaboration on songwriting and production in the Vocaloid scene, further evaluation of Internet communication and freelancing would better discern the specific causes for this global shift. For instance, because artificial intelligence only recently surfaced, the study could not evaluate the significance of machine learning on interpersonal partnership or audience reception. Further evaluation of the interplay between technology and music could include machine learning and whether its involvement would contribute to a similar deconstruction of culture in the West.

Furthermore, the shift from private to public sourcing also raises questions about the rapid fragmentation of popular culture, the sustainability of such ecosystems, and the impact on artistic quality. Replicating the interplay between Vocaloid and the Internet in the West could challenge traditional power structures in the music industry, leading to a democratization of music production. However, it simultaneously has contributed to the rapid growth of amateur music. From an economic standpoint, the conducted study exemplifies that because the Vocaloid economy operates within its Internet audience, learning music theory 'on-site' would inevitably incentivize producers to use prevalent music structures such as extended choruses. Future researchers could consider the sustainability and long-term impacts of the content area.

Future Directions

As for the content area, this study underscored the significance of embracing the complex and unusual to understand the social construction of personal identities, whether as a community or individually, perceived through music. Therefore, open-sourced technology will be a foundational step in replicating similar growth of a participatory culture. As established, traditional industries are hesitant to embrace economic models that challenge their monopolistic control over music production. By integrating technology-based industries with music, audience engagement, and content production are prioritized. For instance, when Crypton intentionally lifted copyrights to facilitate fan creation[6], Japan's digital mediums encouraged rapid dissemination of music, bolstering Internet traffic. The surge in internet activity increased audience participation, resulting in the Vocaloid phenomenon.

Although the Vocaloid phenomenon seems constrained in the Japanese Internet community, the manifestation of Hatsune Miku indicates a "contemporary society immersed in consumption, creative production, and intense involvement with digital technologies"[4]. The rapid integration of social media into daily life illustrates the sensation of Hatsune Miku is not singular. As miniature ecosystems form within these digital platforms, fostered by a globalized world, discussing the consequence of digital culture on conventional societies and methods to adapt will be crucial.

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Appendices

Appendix A1: America Year-End Billboard Charts

Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	0.052	0.11975	0.2155	0.25	0.35	0.09977424517	0.3158706146	0.298	0
	0.15	0.19675	0.276	0.32175	0.575	0.1225951331	0.3501358781	0.425	1
	0.192	0.20775	0.2385	0.25	0.405	0.0614239367	0.2478385295	0.213	1
	0.05	0.2365	0.2855	0.51875	0.643	0.1964715416	0.4432511045	0.593	0
	0.026	0.087	0.165	0.23875	0.525	0.1524710902	0.3904754668	0.499	1
2017	0.06	0.1125	0.185	0.24875	0.483	0.1374859993	0.3707910453	0.423	1
	0.067	0.206	0.231	0.2605	0.4	0.08218738752	0.2866834273	0.333	2
	0.122	0.16325	0.2115	0.26925	0.356	0.07567334772	0.2750878909	0.234	0
	0.013	0.1545	0.2775	0.294	0.338	0.1047961513	0.3237223368	0.325	0
	0.026	0.087	0.165	0.23875	0.525	0.1524710902	0.3904754668	0.499	1
2018	0.083	0.1585	0.318	0.403	0.467	0.1407952019	0.3752268673	0.384	0
	0.084	0.16625	0.2175	0.261	0.429	0.09354713607	0.305854763	0.345	1
	0.095	0.211	0.3115	0.3435	0.392	0.09588048116	0.3096457349	0.297	0
	0.037	0.19	0.242	0.3875	0.525	0.1478281284	0.3844842369	0.488	0
	0.054	0.13025	0.175	0.25875	0.367	0.09724590823	0.311842762	0.313	0
2019	0.103	0.1175	0.1615	0.2225	0.333	0.08529224271	0.2920483568	0.23	0
	0.209	0.2205	0.292	0.33825	0.438	0.07594625292	0.2755834772	0.229	0
	0.116	0.1805	0.2305	0.24225	0.36	0.06702644586	0.2588946617	0.244	1
	0.143	0.237	0.28	0.3305	0.438	0.08769619275	0.2961354297	0.295	0
	0.07	0.11775	0.1725	0.31775	0.421	0.1293898502	0.3597080069	0.351	0
2020	0.111	0.20475	0.2875	0.39225	0.515	0.1393660249	0.3733175925	0.404	0
	0	0.2145	0.3365	0.39925	0.706	0.2076199787	0.4556533537	0.706	1
	0.056	0.1265	0.212	0.242	0.349	0.09447686372	0.3073708895	0.293	0
	0.067	0.2195	0.3525	0.53375	0.794	0.218630993	0.4675799322	0.727	0
	0	0.1265	0.1625	0.29025	0.333	0.1082764466	0.3290538658	0.333	0
2021	0.103	0.15375	0.236	0.32225	0.405	0.1033875664	0.3215393699	0.302	0
	0.097	0.16325	0.2005	0.302	0.508	0.1256103322	0.3544154796	0.411	0
	0.152	0.23725	0.3	0.34725	0.435	0.08682549549	0.2946616627	0.283	0
	0.161	0.21675	0.275	0.385	0.395	0.09301111045	0.3049772294	0.234	0
	0.034	0.129	0.145	0.33125	0.537	0.1659491555	0.4073685746	0.503	0
2022	0.095	0.14525	0.25	0.32575	0.448	0.1290830912	0.3592813539	0.353	0
	0.054	0.18775	0.238	0.261	0.364	0.0890502979	0.2984129654	0.31	1
	0.048	0.17325	0.191	0.31225	0.515	0.1331106474	0.3648433189	0.467	0
	0.071	0.19225	0.2155	0.27275	0.483	0.1092825085	0.3305790503	0.412	2
	0	0.12175	0.1895	0.25525	0.556	0.1608128312	0.4010147518	0.556	1

Appendix A2: Japan Year-End Billboard

Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	0.047	0.1925	0.228	0.304	0.4	0.1006454724	0.3172467059	0.353	0
	0.085	0.17525	0.2215	0.2605	0.357	0.07748182583	0.2783555744	0.272	0
	0.125	0.189	0.256	0.3665	0.679	0.1697569832	0.412015756	0.554	1
	0.083	0.1605	0.244	0.40375	0.429	0.1394967542	0.3734926428	0.346	0
	0.043	0.09425	0.1505	0.20975	0.28	0.08270489707	0.2875845912	0.237	0
2017	0.108	0.16925	0.208	0.35375	0.429	0.1120101682	0.3346792019	0.321	0
	0.098	0.17075	0.2425	0.30975	0.518	0.1353472899	0.3678957596	0.42	0
	0.1	0.19025	0.213	0.239	0.389	0.07600065789	0.2756821683	0.289	2
	0	0.17575	0.2755	0.3685	0.625	0.1800537265	0.4243273813	0.625	0
	0	0.051	0.1175	0.1725	0.523	0.1534973398	0.3917873656	0.523	1
2018	0.074	0.21075	0.2265	0.3455	0.508	0.1367351048	0.3697771015	0.434	0
	0.14	0.256	0.3035	0.35025	0.514	0.1118449323	0.3344322537	0.374	1
	0.054	0.1325	0.1965	0.22075	0.37	0.0920283169	0.3033616932	0.316	1
	0	0.0985	0.15	0.2205	0.385	0.1124907897	0.3353964665	0.385	0
	0.015	0.11025	0.1795	0.21825	0.537	0.1515606223	0.3893078759	0.522	1
2019	0.099	0.28725	0.3525	0.41175	0.525	0.1290435327	0.3592262973	0.426	1
	0.136	0.2265	0.2425	0.3075	0.395	0.07829885766	0.2798193304	0.259	0
	0.091	0.17675	0.187	0.21225	0.345	0.07409910781	0.272211513	0.254	3
	0.146	0.21825	0.305	0.3975	0.636	0.1496297653	0.3868200684	0.49	0
	0.04	0.06925	0.122	0.20775	0.395	0.1091331501	0.3303530688	0.355	0
2020	0.212	0.337	0.383	0.4465	0.548	0.1045230437	0.3233002377	0.336	0
	0.078	0.14475	0.1865	0.31675	0.395	0.1096499987	0.3311344119	0.317	0
	0.098	0.17375	0.2075	0.316	0.409	0.108658742	0.329634255	0.311	0
	0.188	0.25	0.325	0.36475	0.515	0.09773143472	0.3126202724	0.327	0
	0.061	0.15225	0.2	0.219	0.593	0.1563102684	0.3953609343	0.532	2
2021	0.123	0.27375	0.354	0.39875	0.727	0.166083279	0.407533163	0.604	1
	0.098	0.22125	0.237	0.32925	0.449	0.1201543452	0.346632868	0.351	0
	0.143	0.194	0.283	0.295	0.421	0.08309358847	0.2882595852	0.278	0
	0.046	0.10275	0.3295	0.3865	0.591	0.1819824167	0.4265939717	0.545	0
	0.026	0.09125	0.1775	0.2505	0.273	0.09037108682	0.3006178418	0.247	0
2022	0.194	0.333	0.353	0.385	0.489	0.08095489142	0.2845257307	0.295	2
	0	0.157	0.231	0.311	0.348	0.1174543647	0.3427161576	0.348	0
	0.205	0.224	0.308	0.339	0.392	0.06544038848	0.2558131906	0.187	0
	0.065	0.245	0.261	0.319	0.359	0.08646531096	0.2940498444	0.294	1
	0.016	0.061	0.118	0.234	0.308	0.1083298717	0.3291350357	0.292	0

Appendix A3: Vocaloid Collection

Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	0.255	0.40425	0.441	0.4675	0.552	0.08885193676	0.29808042	0.297	2
	0.104	0.1465	0.1645	0.1985	0.317	0.05713930346	0.2390382887	0.213	1
	0.098	0.119	0.15285	0.23925	0.325	0.08361116419	0.2891559513	0.227	0
	0.036	0.10825	0.1535	0.2495	0.414	0.1126020031	0.3355622195	0.378	0
	0.039	0.071	0.1225	0.2205	0.525	0.1710663033	0.4136016239	0.486	2
2017	0.311	0.4425	0.5905	0.6935	0.804	0.1625590149	0.4031860798	0.493	0
	0.045	0.10575	0.164	0.186	0.426	0.1044109935	0.3231268999	0.381	1
	0.077	0.12625	0.1455	0.166	0.345	0.07355761159	0.2712150652	0.268	1
	0.051	0.128	0.249	0.29575	0.472	0.1305780312	0.3613558235	0.421	0
	0	0.0325	0.0785	0.126	0.207	0.06414991123	0.2532783276	0.207	0
2018	0.2	0.30625	0.4375	0.525	0.692	0.1608839817	0.4011034551	0.492	0
	0.118	0.1495	0.179	0.24375	0.333	0.06722342515	0.2592748062	0.215	0
	0.082	0.22275	0.25	0.2545	0.353	0.07810683567	0.279476002	0.271	3
	0.05	0.11975	0.272	0.306	0.436	0.1284594186	0.3584123583	0.386	0
	0.028	0.06425	0.1	0.16925	0.412	0.1372760398	0.3705078135	0.384	2
2019	0.217	0.36375	0.4695	0.54825	0.633	0.1416672549	0.3763871078	0.416	0
	0.1	0.17925	0.22	0.25425	0.29	0.0581233363	0.2410878186	0.19	0
	0.103	0.1655	0.2295	0.2895	0.4	0.09039026496	0.300649738	0.297	0
	0.027	0.122	0.1895	0.3215	0.667	0.2163165376	0.4650984171	0.64	1
	0	0.05175	0.075	0.11575	0.2	0.06148902341	0.2479698034	0.2	0
2020	0.256	0.278	0.392	0.477	0.667	0.1509333002	0.3885013516	0.411	0
	0.078	0.167	0.244	0.292	0.333	0.09322031848	0.3053200263	0.255	0
	0.042	0.148	0.171	0.188	0.273	0.06932712312	0.2633004427	0.231	3
	0	0.094	0.152	0.268	0.417	0.1288365674	0.3589381109	0.417	0
	0	0.078	0.125	0.182	0.409	0.1205260461	0.3471686133	0.409	1
2021	0.123	0.27375	0.354	0.39875	0.727	0.166083279	0.407533163	0.604	1
	0.098	0.22125	0.237	0.32925	0.449	0.1201543452	0.346632868	0.351	0
	0.143	0.194	0.283	0.295	0.421	0.08309358847	0.2882595852	0.278	0
	0.046	0.10275	0.3295	0.3865	0.591	0.1819824167	0.4265939717	0.545	0
	0.026	0.09125	0.1775	0.2505	0.273	0.09037108682	0.3006178418	0.247	0
2022	0.25	0.3565	0.4605	0.5835	0.788	0.162493	0.4031	0.538	0
	0.115	0.20575	0.2195	0.246	0.308	0.05672046466	0.2381605859	0.193	2
	0.152	0.15925	0.185	0.2305	0.442	0.09080283892	0.3013350941	0.29	1
	0.063	0.1475	0.216	0.27	0.5	0.1411475194	0.3756960465	0.437	1
	0	0.0535	0.091	0.132	0.318	0.08857771227	0.2976200804	0.318	1

* Standard Deviation

** This refers to the number of outliers greater or less than the interquartile range within the sample (IQR).

Appendix B: Statistical data within the four categories used for musical trends, blocked by environment and year.
Key:

Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	185	222	233	244.75	313	34.23513465	5.851079785	128	2
	0	28	40	51	87	24.97387524	4.997386841	87	1
	0	0.2685	0.411	0.4665	0.6	0.190613629	0.4365932077	0.6	0
	92	105.75	128.5	140	144	20.22896713	4.497662407	52	0
2017	182	220.75	225	233.75	239	16.88556254	4.109204611	57	1
	12	22.75	32.5	56.75	84	24.11085509	4.910280551	72	0
	0.258	0.33775	0.4085	0.441	0.533	0.09135310005	0.3022467536	0.275	0
	81.2	96.5	121.5	136	155	24.70437658	4.970349744	73.8	0
2018	122	163.75	214.5	243.5	324	63.30666105	7.956548313	202	0
	0	8.5	16	28.5	57	17.94466804	4.236114734	57	0
	0.168	0.2875	0.407	0.53925	0.6	0.1538867188	0.3922839772	0.432	0
	65	85	110	138	154	32.3494805	5.687660372	89	0
2019	145	174.25	181.5	199.75	229	23.76762504	4.875205128	84	0
	4	16	35.5	41	59	19.46963448	4.412440875	55	0
	0.24	0.40825	0.441	0.55175	0.583	0.1082446304	0.3290055172	0.343	0
	97	114.75	132	145.5	168	24.29357482	4.928851268	71	0
2020	165	176.5	185	202.25	238	22.41750308	4.734712566	73	0
	0	12.5	33	45.75	66	21.97498578	4.687748477	66	0
	0	0.39975	0.4725	0.60275	0.939	0.2433591082	0.4933144111	0.939	2
	75	104	111.5	126.75	160	23.34785263	4.831961571	85	0
2021	123	161.75	168	181.25	248	31.61732999	5.622928951	125	2
	11	23	35	36.75	74	20.40697049	4.517407496	63	2
	0.194	0.30325	0.3285	0.47175	0.552	0.1135811506	0.3370180272	0.358	0
	72	102.5	109	136.5	166	27.23988089	5.21918393	94	0
2022	123	161.75	168	181.25	248	31.61732999	5.622928951	125	2
	11	23	35	36.75	74	20.40697049	4.517407496	63	2
	0.194	0.30325	0.3285	0.47175	0.552	0.1135811506	0.3370180272	0.358	0
	72	102.5	109	136.5	166	27.23988089	5.21918393	94	0

Appendix B2: Japan Billboard Year-End

Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	129	236.5	272.5	305	410	79.38828629	8.910010454	281	2
	45	57	64	76	120	21.78557117	4.667501598	75	1
	0	0.3345	0.407	0.47375	0.625	0.1673632111	0.4091004903	0.625	1
	71	77	126	143.5	176	38.13441141	6.175306584	105	0
2017	133	199.75	244.5	264.75	310	52.6502084	7.256046334	177	0
	0	43	59	70.75	74	28.1071363	5.301616386	74	1
	0.222	0.408	0.507	0.63625	0.8	0.1756252639	0.4190766803	0.578	0
	108	136	147.5	156.5	173	21.59346609	4.646877025	65	0
2018	170	215.5	238.5	251.75	308	37.13877877	6.094159399	138	1
	9	46.75	56	67	73	23.31809026	4.82888085	64	2
	0.353	0.472	0.5475	0.63175	0.795	0.1263733885	0.3554903494	0.442	0
	100	111.5	138	154.75	161	23.47315251	4.844909959	61	0
2019	186	226.5	242.5	256.75	325	40.80522842	6.387897027	139	1
	48	57.25	61	77.25	103	17.15808847	4.142232305	55	0
	0.242	0.28575	0.3635	0.4705	0.604	0.1231489162	0.3509257987	0.362	0
	81	100.25	135.5	160.25	173.7	34.92678215	5.909888505	92.7	0
2020	212	243	255.5	295	326	37.58264966	6.130468959	114	0
	38	52	61	81	93	19.17869188	4.37934834	55	0
	0.186	0.31875	0.416	0.49275	0.571	0.1372086813	0.370416902	0.385	0
	90	105.5	128.5	151	173.7	30.91184778	5.559842424	83.7	0
2021	187	215	266	277.5	340	46.36282035	6.809024919	153	0
	53	61.75	69.5	78	123	20.2144063	4.496043405	70	1
	0.277	0.36725	0.434	0.5395	0.579	0.1090176336	0.3301781847	0.302	0
	114	129.75	143	153.5	172	17.08150397	4.132977615	58	0
2022	193	236	265.5	275.5	292	30.34047535	5.508218891	99	0
	0	55	70.5	77.5	86	29.95107121	5.472757185	86	2
	0	0.383	0.41	0.492	0.522	0.1612209491	0.4015232859	0.522	1
	79	83.25	93	132.75	185	37.1556785	6.095545791	106	0

Appendix B3: Vocaloid Collection

Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	156	179.25	189	200.5	266	32.04233311	5.660594766	110	1
	31	44.25	57.5	62.5	65	12.82358937	3.581003962	34	0
	0.184	0.314	0.4	0.42175	0.484	0.0942432432	0.306990624	0.3	0
	65	83.25	128	143	150	34.34077589	5.860100331	85	0
2017	146	183.75	202	222.75	246	31.9902763	5.655994722	100	0
	0	52.5	57	64	67	19.7551681	4.444678627	67	1
	0.121	0.397	0.427	0.45625	0.667	0.1428388758	0.3779403072	0.546	3
	90	113.25	147.5	160	220	38.04032948	6.167684288	130	0
2018	90	158	185	232.75	266	60.54346464	7.780968105	176	0
	0	40.75	50.5	67.5	77	22.8670068	4.781945922	77	1
	0.328	0.438	0.4605	0.54075	0.898	0.1577749452	0.397208944	0.57	1
	72	106.5	130	147	185	35.69702758	5.974698953	113	0
2019	106	158.25	178.5	198	271	49.88219455	7.062732796	165	1
	0	45	49	57.75	60	23.04608909	4.800634238	60	2
	0.205	0.37125	0.414	0.4995	0.6	0.1182278403	0.3438427552	0.395	0
	89	110	121	155.25	170	28.94822965	5.380355904	81	0
2020	212	243	255.5	295	326	37.58264966	6.130468959	114	0
	38	52	61	81	93	19.17869188	4.37934834	55	0
	0.186	0.31875	0.416	0.49275	0.571	0.1372086813	0.370416902	0.385	0
	90	105.5	128.5	151	173.7	30.91184778	5.559842424	83.7	0
2021	137	181	212	240.25	400	77.05128162	8.777885943	263	1
	16	48	54	68	125	29.79932885	5.458876153	109	2
	0.167	0.341	0.375	0.485	0.846	0.1916029604	0.4377247542	0.679	1
	95	129	130	170	173	27.20957756	5.21628005	78	0
2022	148	159.75	187.5	199.5	251	35.65903345	5.971518521	103	0
	34	45.5	54	58.75	71	11.17586686	3.343032584	37	0
	0.25	0.388	0.397	0.427	0.667	0.1079298126	0.3285267304	0.417	3
	96	120	129	134.25	144	15.87625761	3.984502178	48	1

Appendix C: Statistical data within the two categories used for differences in collaboration, blocked by environment and year.
Key:

Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	2	3	4	5.75	8	2.065591118	1.437216448	6	0
	0	0	1	1	4	1.197219	1.094175032	4	1
	3	3	5	5	12	2.830390629	1.682376482	9	1
2017	0	4.25	5	6	7	2.002775851	1.415194634	7	1
	0	0	0	1.75	3	1.135292424	1.06550102	3	0
	2	5.25	6	6	8	1.779513042	1.333983899	6	3
2018	0	2.25	3	4	12	3.446415207	1.856452317	12	2
	0	0	1	1.75	5	1.636391694	1.279215265	5	1
	2	3	4	5.75	17	4.477102237	2.115916406	15	1
2019	1	3	3.5	5.75	9	2.366431913	1.538321135	8	0
	0	0	1	1.75	3	1.197219	1.094175032	3	0
	3	4	4	5.75	10	2.758824226	1.660970869	7	2
2020	2	2	3	5.75	12	3.272783389	1.809083577	10	1
	0	0	0	2	3	1.197219	1.094175032	3	0
	2	4	4.5	5.75	12	2.71006355	1.646227065	10	1
2021	1	3	3	4	7	1.702938637	1.30496691	6	3
	0	0	1.5	3	5	1.87379591	1.368866652	5	0
	3	3.25	4.5	6.5	11	2.915475947	1.707476485	8	0
2022	1	2	3.5	4	8	2.057506582	1.434401123	7	1
	0	0	1	1	4	1.197219	1.094175032	4	1
	2	3	4	4.75	5	1.932183566	1.390030059	3	1

Appendix C2: Japn Year-End Charts
Key:

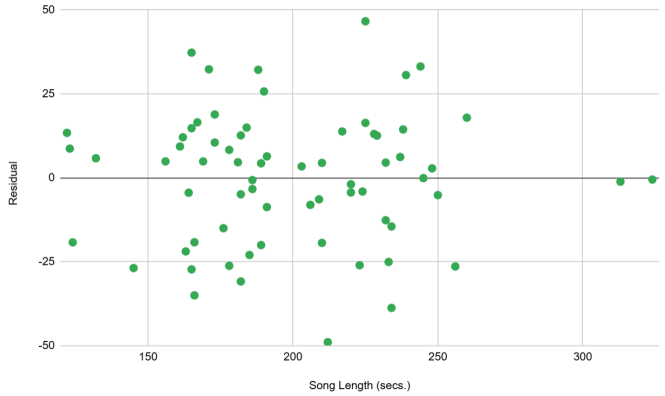
Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	1	1	1.5	2.75	8	2.162817093	1.470651928	7	1
	0	0	0	0.75	2	0.6992058988	0.8361853256	2	1
	1	1.25	2.5	3	8	2.057506582	1.434401123	7	1
2017	1	1.25	2	3	4	1.032795559	1.016265496	3	0
	0	0	0	0	1	0.4216370214	0.649335831	1	2
	1	1.25	2	3.75	4	1.264911064	1.12468265	3	0
2018	1	1	1	2	10	2.790858092	1.670586152	9	1
	0	0	0	1	2	0.7071067812	0.8408964153	2	0
	1	1	2.5	3	10	2.699794231	1.643105058	9	1
2019	1	1	1	1.75	6	1.619327707	1.272528077	5	2
	0	0	0	0	2	0.6749485577	0.8215525289	2	2
	1	1	1	2.75	6	1.728840331	1.31485373	5	1
2020	0	0.25	1	1	3	0.8755950358	0.9357323526	3	1
	0	0	0	1	1	0.5163977795	0.7186082239	1	0
	1	1	1	1	4	0.9486832981	0.9740037464	3	1
2021	1	1.25	2	3	4	1.032795559	1.016265496	3	0
	0	0	0	0	1	0.316227766	0.5623413252	1	1
	1	1.25	2.5	3	4	1.059349905	1.029247252	3	0
2022	1	1	1	2.75	3	0.9486832981	0.9740037464	2	0
	0	0	0	0	1	0.316227766	0.5623413252	1	1
	1	1	1.5	2.75	3	0.9189365835	0.9586118002	2	0

Appendix C3: Vocaloid Collection

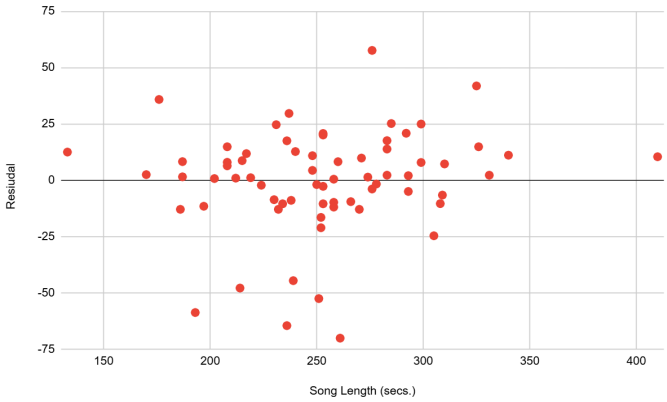
Year	Min.	Q1	Median	Q3	Max.	S. D.*	Variance	Range	Outliers**
2016	0	0	0	0	1	0.316227766	0.5623413252	1	1
	0	1	1	1	2	0.4714045208	0.686589048	2	2
	1	1	1	1	2	0.316227766	0.5623413252	1	1
2017	0	0	1	1	1	0.5163977795	0.7186082239	1	0
	0	0	0	1	3	0.9660917831	0.9828996811	3	1
	1	1	1	1	1	0.632455532	0.7952707288	0	1
2018	0	0	0	0	1	0.316227766	0.5623413252	1	1
	0	1	1	1	1	0.316227766	0.5623413252	1	1
	1	1	1	1	1	0	0	0	0
2019	0	0	0	1	1	0.5	0.7071067812	1	0
	0	0	1	1	1	0.5	0.7071067812	1	0
	1	1	1	1	1	0	0	0	0
2020	0	0	0.5	1	1	0.5270462767	0.7259795291	1	0
	0	0	0.5	1	2	0.6992058988	0.8361853256	2	0
	1	1	1	1	1	0.316227766	0.5623413252	0	1
2021	0	0	0	1	1	0.5163977795	0.7186082239	1	0
	0	0	1	1	1	0.5163977795	0.7186082239	1	0
	1	1	1	1	1	0	0	0	0
2022	0	0.25	1	1	1	0.4830458915	0.6950150297	1	0
	0	0	0	0.75	1	0.4830458915	0.6950150297	1	0
	1	1	1	1	1	0	0	0	0

Appendix D: Residual plots to determine if a linear regression model is appropriate for the relationship between song length and length before chorus*.
*Because songs without a chorus were statistically insignificant, their corresponding residual is not shown.

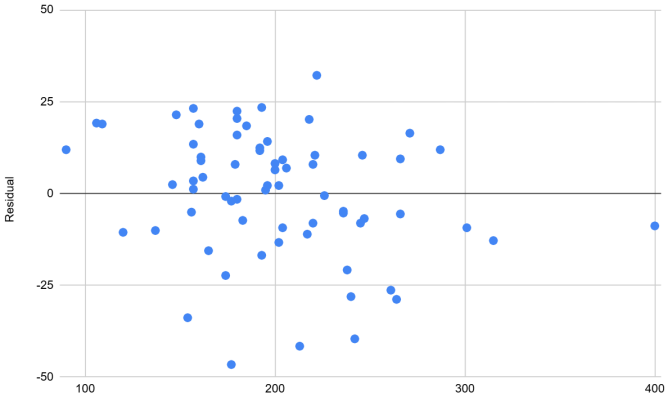
Appendix D1. American Billboard Year-End Charts



Appendix D2. Japan Year-End Charts

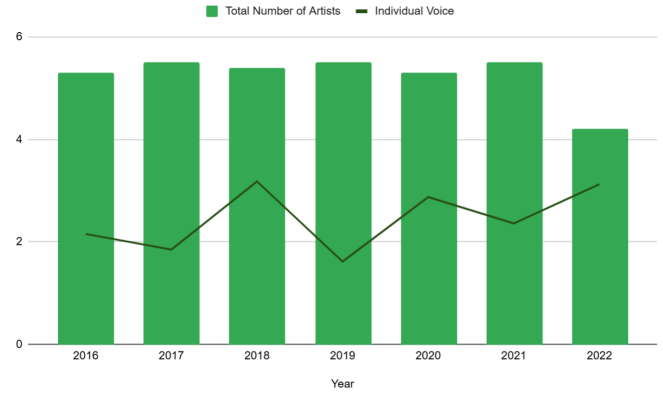


Appendix D3. Vocaloid Collection

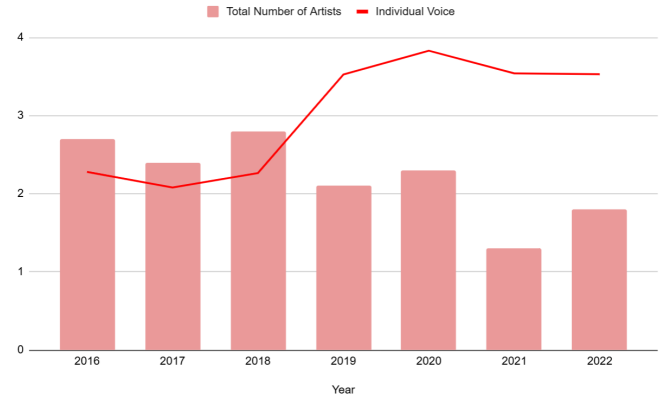


Appendix E: Individual Voice and Total Number of Artists Bar and Line Graphs
Note. For a more identifiable comparison, the individual voice percentages were proportionally recalculated. Therefore, specific quantities should not be directly and only general trends should be considered.

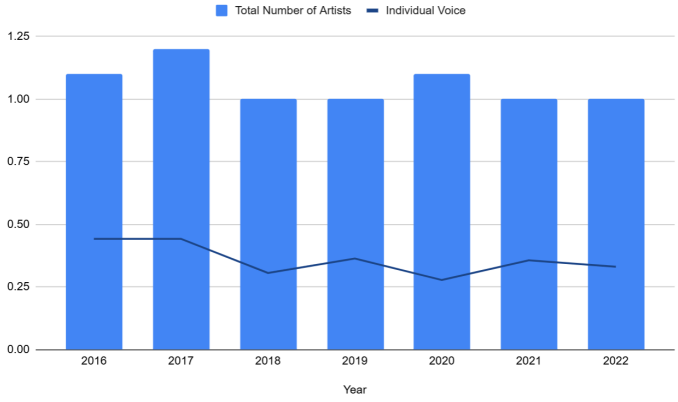
Appendix E1. America Year-End Charts



Appendix E2. Japan Year-End Charts



Appendix E3. Vocaloid Collection



Appendix F: Percentage of Lyrics with Pronoun Usage (I) and Pronoun Usage (Other) Across Seven Years For Each Environment