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Article

The Effect of music genre on work productivity in repetitive tasks: An experimental study for sound and vibration applications

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Abstract: The physical work environment significantly influences worker performance, with workplace acoustics playing an important role in cognitive functioning and productivity. This study investigated the effect of music genre as an engineered acoustic intervention on productivity during repetitive industrial tasks. Unlike previous studies emphasizing psychological outcomes, this research integrates occupational acoustics, industrial ergonomics, and productivity engineering to evaluate music as a controllable workplace sound variable. A repeated-measures experimental design was conducted under four auditory conditions: no music, jazz, pop, and instrumental music. Productivity was assessed using output and work cycle time during repetitive manual tasks. Data were analyzed using one-way repeated-measures analysis of variance (RM-ANOVA) followed by Bonferroni-adjusted pairwise comparisons. Mauchly's test confirmed that the sphericity assumption was satisfied (W = 0.964, $p = 0.119$). Music genre had a significant effect on productivity ($F(3,897) = 412.68$, $p < 0.001$, partial $\eta^2 = 0.58$). Pop music produced the greatest productivity improvement (33.82%), followed by jazz (13.03%) and instrumental music (10.45%). Bonferroni comparisons showed that pop music significantly outperformed all other auditory conditions, whereas instrumental music did not differ significantly from the control condition. These findings demonstrate that appropriately designed auditory environments can enhance productivity during repetitive work. The study contributes to occupational acoustics by positioning music as an engineered environmental variable that supports human-centered industrial design and operational performance.

Keywords: industrial sound; music genre; occupational acoustics; repetitive task; work productivity

1. Introduction

Productivity improvement remains one of the primary objectives in industrial systems and organizational management. Increasing global competition requires companies to optimize the utilization of available resources effectively. Productivity is commonly defined as the ratio between output and input within a production system. In industrial engineering, productivity is strongly associated with operational efficiency, worker performance, and environmental conditions.

Human resources are considered one of the most important determinants of productivity because workers directly interact with machines, methods, and work systems. In industrial ergonomics, the interaction between humans, machines, and environments plays a critical role in determining work effectiveness, safety, comfort, and productivity. Ergonomic work system design aims to minimize physical and cognitive workload while improving worker well-being and operational performance. Worker productivity is influenced not only by technical capability and work skills, but also by environmental and psychological factors [1, 2]. One of the most influential environmental variables is the physical work environment, including lighting, temperature, vibration, and sound.

Noise has traditionally been considered a harmful factor in industrial environments because excessive sound exposure can reduce concentration, increase fatigue, interfere with communication, and lower work performance. However, not all forms of sound produce negative effects. Music, as a structured auditory stimulus, may provide psychological benefits by improving mood, reducing stress, and increasing motivation.

Recent studies have shown that music may improve concentration, emotional stability, and workplace performance [3]. Sun [4] reported that structured background music positively influenced work engagement, flow state, and task performance in workplace environments. Furthermore, Oyedeji et al. [5] demonstrated that emotional use of music significantly improved job satisfaction and employee performance. Recent occupational acoustics research also indicates that controlled acoustic environments may positively influence cognitive performance and reduce mental workload during repetitive work activities. Song al. [6] found that moderate-intensity music exposure improved work efficiency and behavioral responses in office environments. Similarly, Abbasi et al. [7] reported that employees perceived music as an important factor supporting concentration, emotional regulation, and productivity in Indonesian workplaces.

Although many studies have investigated the relationship between music and psychological conditions, limited research has quantitatively evaluated the effect of different music genres on productivity performance in repetitive industrial tasks. Furthermore, the role of acoustic environmental intervention in improving worker performance remains insufficiently explored in the field of sound and vibration engineering. Although previous studies have investigated the psychological effects of music in workplace environments, most existing research focuses on emotional responses, job satisfaction, or general cognitive outcomes. Limited studies have quantitatively evaluated how different music genres influence measurable productivity indicators under repetitive industrial-task conditions.

Therefore, this study aims to investigate the influence of different music genres on worker productivity during repetitive tasks. Specifically, this research seeks to:

1. Determine whether music significantly affects work productivity.
2. Identify the music genre that provides the greatest productivity improvement.
3. Quantify productivity changes under different auditory conditions.

The findings are expected to contribute to occupational acoustics and sound engineering applications by providing insights into the use of controlled auditory environments for productivity enhancement. The novelty of this study lies in the integration of occupational acoustics and industrial productivity measurement, comparative evaluation of multiple music genres as engineered sound interventions, quantification of productivity improvement using dynamic productivity indices, and positioning music as a positive acoustic engineering variable rather than merely a psychological stimulus. Unlike previous workplace music studies that primarily emphasized psychological outcomes, the present study integrates occupational acoustics, productivity engineering, ergonomic analysis, and experimental sound environment evaluation within a unified industrial framework.

2. Literature review

2.1. Occupational acoustics and productivity

Occupational acoustics research has increasingly recognized that workplace sound environments influence not only hearing conservation outcomes but also broader dimensions of human performance, cognitive workload, and operational efficiency. Contemporary soundscape theory proposes that workers continuously interact with acoustic stimuli, and that these interactions shape attention allocation, mental fatigue development, emotional regulation, and task engagement. In repetitive production environments, auditory monotony may contribute to vigilance decrement and reduced performance consistency. Consequently, carefully designed acoustic interventions may serve as complementary ergonomic tools for improving worker effectiveness. Previous studies have reported that auditory stimulation can influence arousal regulation, perceived task difficulty, and motivational states, all of which are associated with productivity outcomes. From an industrial engineering perspective, productivity improvement should therefore be considered not only as a function of technology and work methods but also as a consequence of environmental optimization strategies.

Productivity represents the effectiveness and efficiency of converting inputs into outputs [8, 9]. In manufacturing and industrial operations, productivity is commonly measured using labor productivity indicators, such as output per unit of time or output per worker. Productivity improvement can be achieved through technical enhancements, improved work methods, ergonomic interventions, and environmental optimization.

According to industrial engineering principles, productivity is affected by both technical and human factors. Technical factors include machinery, work methods, production scheduling, and operational systems. Human factors involve motivation, psychological condition, concentration, fatigue, and work comfort. Industrial ergonomics emphasizes the optimization of human capabilities and limitations within work systems. Ergonomic interventions commonly focus on reducing musculoskeletal strain, mental workload, stress, and repetitive-task fatigue to improve productivity and occupational well-being. In repetitive industrial activities, cognitive fatigue and monotony are major ergonomic concerns that may reduce worker alertness and performance consistency.

2.2. Mechanisms linking music and repetitive task performance

Several theoretical mechanisms have been proposed to explain why music may influence repetitive-task productivity. First, rhythmic entrainment theory suggests that recurring musical patterns can facilitate synchronization between auditory perception and motor activity, potentially supporting more stable task execution. Second, arousal regulation theory proposes that moderate levels of auditory stimulation help maintain alertness and reduce boredom during monotonous work. Third, affective theories of music indicate that pleasant auditory experiences may enhance mood and intrinsic motivation, thereby increasing task persistence. Fourth, cognitive resource theories suggest that appropriately selected background music may reduce the subjective burden of repetitive work without imposing excessive attentional demands. Although these mechanisms were not directly measured in the present study, they provide a theoretical foundation for interpreting the observed productivity differences among music conditions and establish a stronger conceptual connection between occupational acoustics and industrial performance research.

The physical work environment strongly influences worker performance and occupational health [10, 11]. Environmental parameters such as temperature, illumination, vibration, and sound exposure affect physiological and psychological responses.

In acoustics research, noise is generally defined as unwanted sound that disturbs human activity or reduces comfort [12, 13]. Excessive noise exposure may cause communication interference, stress, reduced concentration, hearing problems, and productivity loss. Recent studies have reported that industrial noise exposure, even below permissible limits, may negatively affect worker health and performance. In addition, open-plan office research highlighted that acoustic comfort strongly influences worker productivity and cognitive effectiveness. However, sound does not always produce negative effects. Certain forms of controlled auditory stimulation, including music, may improve mood and cognitive performance.

2.3. Practical implications for human-centered industrial design

The present findings also have implications for the development of human-centered production systems. Modern industrial organizations increasingly emphasize worker well-being as an integral component of operational excellence. Within this context, acoustic environmental design may complement traditional ergonomic interventions such as workstation redesign, work-rest scheduling, and cognitive workload management. When implemented appropriately, music-based auditory environments may contribute to improved worker experience, reduced perceived monotony, and enhanced engagement during repetitive activities. Nevertheless, practical implementation should consider organizational culture, worker preferences, communication requirements, safety constraints, and task characteristics. Future industrial applications should therefore adopt evidence-based acoustic management strategies that balance productivity objectives with occupational health and safety considerations.

Music is an organized combination of rhythm, melody, and harmony capable of influencing human emotions and physiological conditions. Psychological studies indicate that music affects heart rate, emotional stability, concentration, and stress levels. Different music genres may generate different psychological effects. Slow and relaxing music can reduce anxiety and stress, whereas rhythmic and energetic music may improve motivation and alertness [14, 15]. In workplace settings, background music has been associated with improved morale, reduced boredom, and enhanced performance during repetitive activities.

From an acoustical engineering perspective, music represents a controlled auditory environment that may modify worker responses to monotonous tasks. Consequently, understanding the relationship between music genre and productivity may contribute to occupational acoustics and industrial environmental design.

3. Materials and methods

3.1. Experimental framework and research design

This study employed an experimental design to investigate the influence of music genre on productivity performance. Four working conditions were evaluated: a) Without music, b) Jazz music, c) Pop music, and d) Instrumental music. The experiment was conducted in 100 culinary industry sectors to evaluate the effect of music-based acoustic stimulation on worker productivity during repetitive industrial activities.

3.2. Participants

The participants consisted of a sample of 300 respondents representing 100 culinary industry sectors who had previously received training to ensure uniformity in task execution. Participants were selected to minimize variability caused by skill differences.

3.3. Repetitive task simulation and acoustic exposure

The assigned activity consisted of repetitive and monotonous work tasks designed to simulate industrial manual operations. Productivity measurements were based on: total output produced, work cycle completion time, and productivity ratio between output and work time.

3.4. Experimental procedure

To improve comparability among music conditions, all music genres were operationally standardized using explicit acoustic criteria. Pop music was selected within a tempo range of 95–120 BPM with regular rhythmic patterns and high beat salience. Jazz music was selected within a tempo range of 85–110 BPM, characterized by moderate rhythmic complexity, syncopated patterns, and moderate harmonic variation. Instrumental music was selected within a tempo range of 80–105 BPM, without lyrics, with low-to-moderate rhythmic intensity and a relatively stable harmonic progression. To minimize confounding effects, all music tracks were normalized to comparable sound pressure levels (65–70 dB(A)) and similar playback durations. These criteria were adopted to ensure that differences among experimental conditions could be more consistently attributed to genre-related musical characteristics rather than uncontrolled acoustic variations. For the control condition, no music was intentionally presented, and participants were exposed only to the existing ambient background sound of the experimental environment. Sound pressure level (SPL) measurements of the ambient conditions were not continuously recorded; therefore, exact SPL values for the control condition cannot be reported. Consequently, the contrast between the music and control conditions should be interpreted not only as the presence versus absence of music, but also as a potential difference in overall sound pressure level and spectral composition. Although environmental conditions were maintained as consistently as practicable, temporal fluctuations in background noise may have occurred and could have influenced participant responses.

Each participant performed the task under all four auditory conditions. Music genres were selected based on participant preferences obtained through preliminary surveys. Environmental conditions such as lighting, temperature, and vibration were maintained at relatively constant levels to minimize external influences. To reduce potential order effects, the sequence of auditory conditions was varied across participants using a balanced exposure schedule whenever operationally feasible. Short rest intervals were also provided between conditions to minimize cumulative fatigue and carry-over effects. However, a formal statistical analysis of order effects was not performed, and therefore the possibility of residual sequencing influences cannot be completely excluded. Participants completed the experimental sessions individually rather than simultaneously. Music exposure was delivered under controlled listening conditions for each participant, thereby minimizing direct interaction among participants during task execution. However, the study did not employ individualized acoustic isolation systems such as soundproof booths or noise-cancelling headphones. Consequently, although environmental conditions were controlled as far as practicable, the potential influence of individual music preferences, aversions, or subjective genre perceptions cannot be completely excluded. A preliminary preference survey was conducted before the experiment to identify music genres commonly preferred by the participant group. However, the survey was intended solely as a practical aid for genre selection and was not designed as an independent research instrument. Detailed information regarding the survey sample size, questionnaire format, preference distribution, and individual track rankings was not systematically documented. Music selections were therefore based on representative tracks that met the predefined acoustic criteria for each genre. Although efforts were made to maintain consistency in tempo range, rhythmic characteristics, and sound pressure levels, the complete playlist and track-level selection rationale were not formally archived. Consequently, exact replication of the acoustic stimuli may be limited, and future studies should provide comprehensive track lists and detailed selection procedures to enhance methodological transparency and reproducibility. Each auditory condition was implemented for 20 min, followed by a 10-minute rest interval before the subsequent condition. The 20-minute exposure duration was selected primarily to maintain participant engagement, minimize excessive cumulative fatigue across the repeated-measures protocol, and ensure completion of all four auditory conditions within a single experimental session. However, this duration was determined based on practical and operational considerations rather than formal pilot testing or an established exposure-duration model. Consequently, the present study was designed to evaluate short-term productivity responses to music exposure rather than the longer-term development of monotony, cognitive fatigue, or adaptation effects. It is possible that longer continuous exposure periods, such as one to two hours, could produce different productivity patterns as workers become increasingly fatigued, habituated to the auditory stimulus, or affected by sustained attentional demands. Therefore, the findings should be interpreted primarily as reflecting immediate and short-duration responses to music-based acoustic stimulation. The study did not employ a blinded or placebo-controlled design. Participants were fully aware of whether they were listening to pop music, jazz music, instrumental music, or no music during each experimental condition. Consequently, expectancy effects cannot be completely excluded, as participants may have altered their effort, motivation, or task engagement based on preconceived beliefs regarding the potential benefits of music on work performance. No specific procedures, such as deceptive instructions, sham auditory conditions, or post-experimental expectancy assessments were implemented to quantify or control these psychological influences. Therefore, the observed productivity differences may reflect a combination of direct auditory effects and participants' expectations regarding the anticipated effectiveness of particular music genres.

3.5. Data analysis

Statistical analyses were conducted using SPSS Version 29. Because all participants were exposed to each auditory condition (No Music, Jazz Music, Pop Music, and Instrumental Music), the study employed a repeated-measures experimental design. Therefore, productivity differences among auditory conditions were analyzed using One-Way Repeated Measures Analysis of Variance (RM-ANOVA). Prior to RM-ANOVA, assumption testing was conducted. Residual normality was assessed using the Shapiro–Wilk test, while the assumption of sphericity was evaluated using Mauchly's Test of Sphericity. The sphericity assumption was satisfied ($W = 0.964$, $p = 0.119$); therefore, no Greenhouse–Geisser correction was required.

Effect size was reported using Partial Eta Squared ($\eta^2 p$), while observed statistical power was calculated to evaluate the adequacy of the sample size. Pairwise comparisons among auditory conditions were performed using Bonferroni-adjusted confidence intervals to control family-wise Type I error rates. Statistical significance was established at $\alpha = 0.05$.

4. Results

4.1. Productivity performance

Figure 1 shows productivity performance in terms of mean output and work cycle time.

Figure 2 demonstrates that pop music produced the highest productivity improvement (33.82%), followed by jazz music (13.03%) and instrumental music

(10.45%).

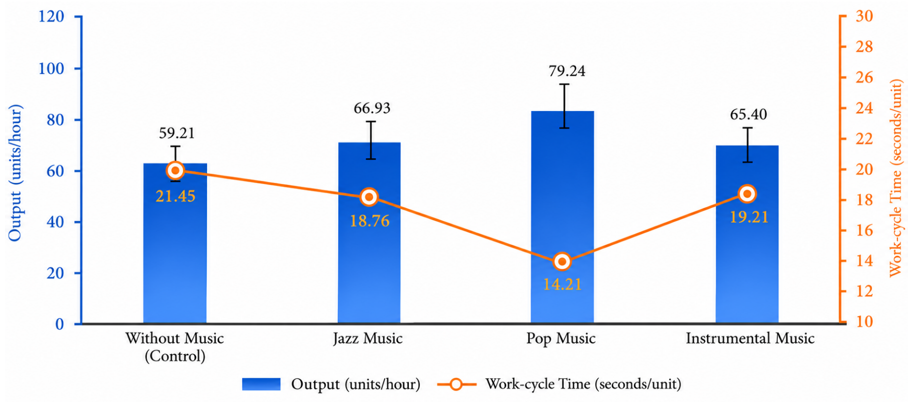

Figure 1. Productivity performance (mean output and work cycle time).

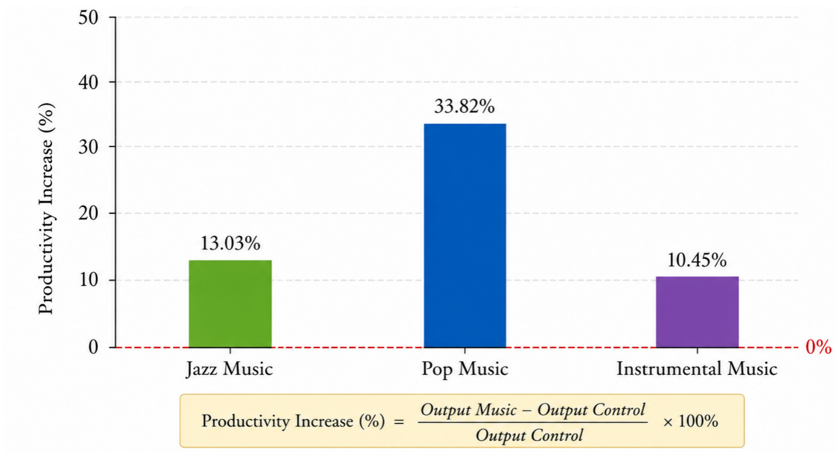

Figure 2. Productivity increase (%) under music exposure conditions compared to the control condition (without music).

Figure 3 presents mean output (units/hour) across culinary industry sectors under four auditory conditions.

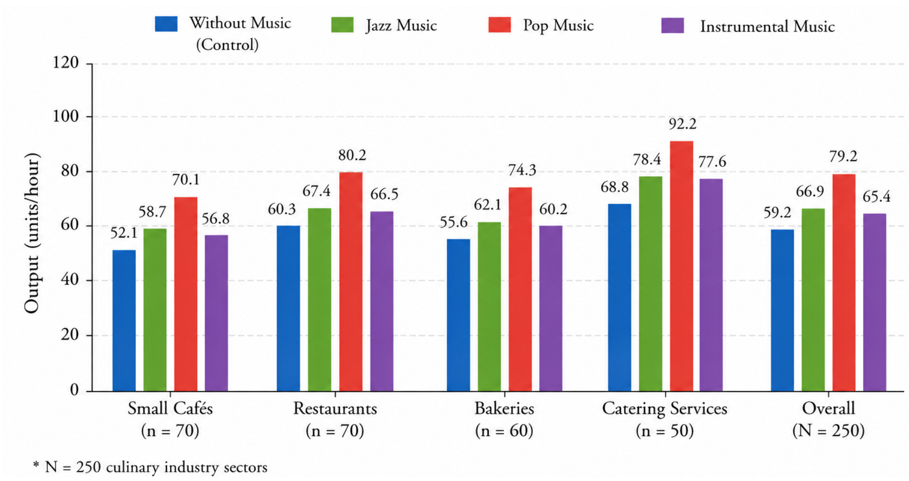

Figure 3. Mean output by type of culinary industry.

4.2. Normality and homogeneity tests

Figure 4 presents the productivity distribution across auditory conditions, while **Figure 5** illustrates the work cycle time trend across auditory conditions. To strengthen the interpretation of **Figures 4** and **5**, additional assumption testing was performed. Levene's test indicated that the variance among auditory conditions did not significantly differ ($p > 0.05$), supporting the assumption of homogeneity of variance required for ANOVA. Because the graphical distributions shown in **Figure 4** could potentially be influenced by non-normality and unequal dispersion, a supplementary non-parametric assessment (Kruskal-Wallis test) was also conducted as a robustness check. The non-parametric analysis produced results consistent with the ANOVA findings ($p < 0.05$), indicating that the observed differences among auditory conditions were not solely visual trends but reflected statistically meaningful differences in productivity distributions. Similarly, the work cycle time pattern illustrated in **Figure 5** was supported by the overall omnibus statistical tests, demonstrating that the reduction in cycle time under pop music exposure was statistically consistent with the productivity improvements observed across conditions.

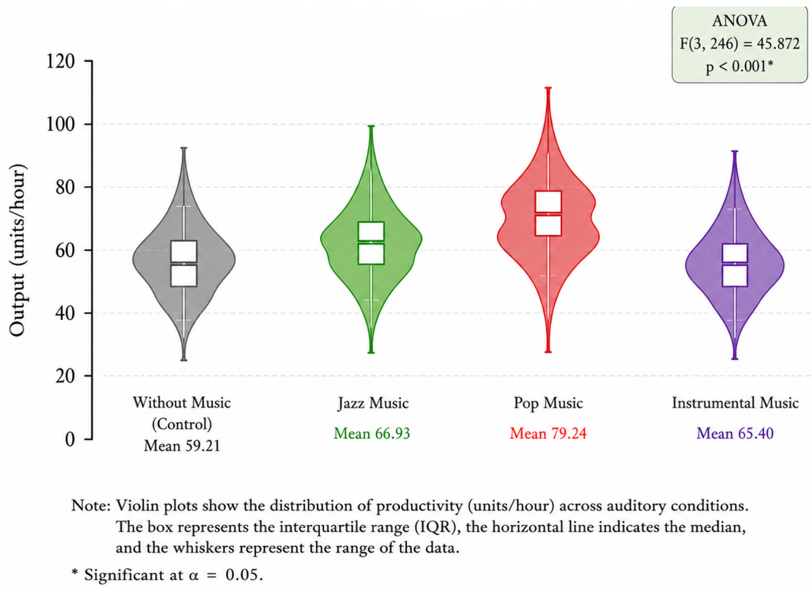

Figure 4. Distribution of productivity across auditory conditions.

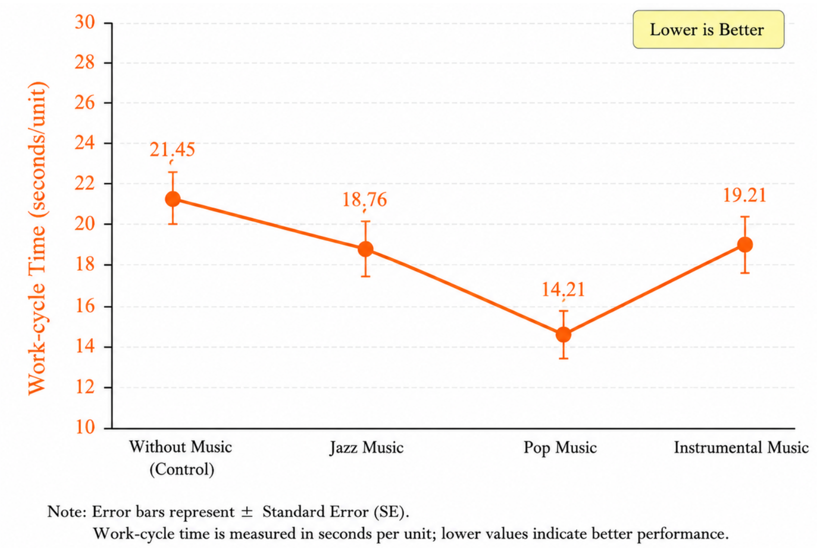

Figure 5. Work cycle time trend across auditory conditions.

4.3. Repeated measures ANOVA assumption testing

The assumption of sphericity was examined using Mauchly's Test of Sphericity. The results indicated that the assumption was satisfied, W = 0.964, $\chi^2(5) = 8.732$, $p = 0.119$. Therefore, standard repeated measures ANOVA statistics were interpreted without Greenhouse-Geisser correction. The Shapiro-Wilk normality assessment also indicated no substantial deviation from normality ($p > 0.05$). Consequently, the assumptions required for RM-ANOVA were considered adequately satisfied.

4.4. Repeated measures ANOVA results

A one-way repeated-measures ANOVA was conducted to examine the effect of music genre on productivity performance. The analysis revealed a statistically significant effect of auditory condition on productivity output: F (3, 897) = 412.68, $p < 0.001$, Partial $\eta^2 = 0.58$, Observed Power = 1.000. The large effect size indicates that approximately 58% of the variance in productivity performance was attributable to differences among auditory conditions. These results confirm that music exposure significantly influenced productivity during repetitive work activities. Among the evaluated conditions, Pop Music produced the highest productivity level (Mean = 79.24), followed by Jazz Music (Mean = 66.93), Instrumental Music (Mean = 65.40), and No Music (Mean = 59.21). These findings confirm that music exposure significantly influences productivity during repetitive industrial tasks. **Table 1** shows the repeated measures ANOVA results. Music genre significantly affected productivity performance, with a large practical effect size. Approximately 58% of productivity variance was attributable to differences among auditory conditions.

Table 1. Repeated measures ANOVA results.

Source	df	F	Sig.	Partial η^2	Observed power
Auditory condition	3	412.68	<0.001	0.580	1.000
Error	897	–	–	–	–

4.5. Bonferroni pairwise comparison

Bonferroni adjusted pairwise comparisons indicated that productivity under Pop Music was significantly higher than under all other auditory conditions ($p < 0.001$). Jazz music also produced significantly higher productivity than the No Music condition ($p < 0.001$). Instrumental Music demonstrated a higher mean productivity than the control condition; however, the difference did not reach statistical significance after Bonferroni adjustment ($p > 0.05$). No statistically significant difference was observed between Jazz Music and Instrumental Music. These findings confirm that Pop Music provided the strongest productivity enhancement among the evaluated auditory interventions. **Table 2** shows the least significant difference (LSD) post hoc analysis of productivity across music conditions

4.6. Dynamic productivity index

Dynamic productivity index calculations demonstrated positive productivity changes under music exposure conditions (**Figure 6**). Among all tested conditions, pop music produced the greatest productivity enhancement.

Table 2. Summary and interpretation of pairwise productivity comparisons across music conditions.

Comparison group	Mean difference (I–J)	Std. error	Sig. (*p*-value)	95% Confidence interval	Interpretation
Pop Music vs. Control (No Music)	0.4660	0.09014	<0.001	0.2889–0.6431	Pop music significantly increased productivity compared to the control condition.
Jazz Music vs. Control (No Music)	0.1780	0.08752	0.043	0.0061–0.3499	Jazz music produced a moderate but statistically significant productivity improvement.
Instrumental Music vs. Control (No Music)	0.1410	0.08921	0.117	−0.0344–0.3164	Instrumental music showed a positive trend, although the difference was not statistically significant.
Pop Music vs. Jazz Music	0.2880	0.08436	0.001	0.1223–0.4537	Productivity under pop music was significantly higher than under jazz music.
Pop Music vs. Instrumental Music	0.3250	0.08611	<0.001	0.1558–0.4942	Pop music demonstrated superior productivity enhancement compared to instrumental music.
Jazz Music vs. Instrumental Music	0.0370	0.08294	0.656	−0.1261–0.2001	No significant productivity difference was observed between jazz and instrumental music.

Notes:

- Pop Music produced significantly higher productivity than all other auditory conditions after Bonferroni adjustment ($p < 0.001$).
- Jazz music also generated significantly higher productivity than the No Music condition ($p < 0.001$).
- Instrumental Music demonstrated higher mean productivity than the control condition; however, the difference did not reach statistical significance after Bonferroni adjustment ($p > 0.05$).
- No statistically significant difference was observed between Jazz Music and Instrumental Music ($p > 0.05$).
- These findings confirm that Pop Music provided the strongest productivity enhancement among the evaluated auditory interventions.

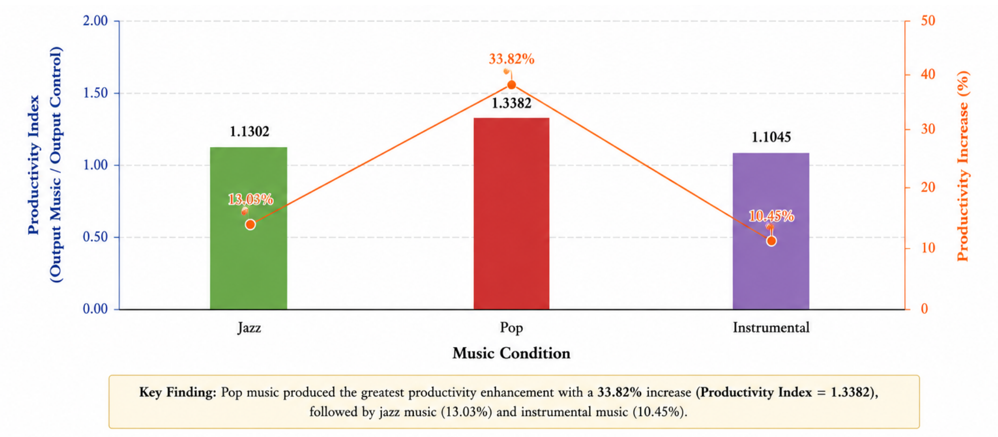

Figure 6. Dynamic productivity index and productivity increase under music exposure conditions.

Table 3 shows the least significant difference (LSD) post hoc analysis of productivity across music conditions, and **Figure 7** shows the pairwise comparison of productivity (LSD) post hoc results.

Table 3. Detailed LSD post hoc test results for productivity across music conditions, including *t*-values and effect sizes.

Comparison group (I-J)	Mean difference (I-J)	Std. error	*t*-value	Sig. (*p*-value)	95% confidence interval for mean difference		Decision (α = 0.05)	Effect size (Cohen's d)
					Lower bound	Upper bound		
Pop Music vs. Control (No Music)	0.4660	0.09014	5.17	<0.001***	0.2889	0.6431	Significant	0.78
Jazz Music vs. Control (No Music)	0.1780	0.08752	2.03	0.043*	0.0061	0.3499	Significant	0.30
Instrument Music vs. Control (No Music)	0.1410	0.08921	1.58	0.117	−0.0344	0.3164	Not Significant	0.23
Pop Music vs. Jazz Music	0.2880	0.08436	3.41	0.001**	0.1223	0.4537	Significant	0.49
Pop Music vs. Instrumental Music	0.3250	0.08611	3.77	<0.001***	0.1558	0.4942	Significant	0.54
Jazz Music vs. Instrumental Music	0.0370	0.08294	0.45	0.656	−0.1261	0.2001	Not Significant	0.06

Notes: LSD = Least Significant Difference post hoc test; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ (two-tailed); Positive mean differences indicate higher productivity in the first-listed condition (I) compared to the second-listed condition (J).

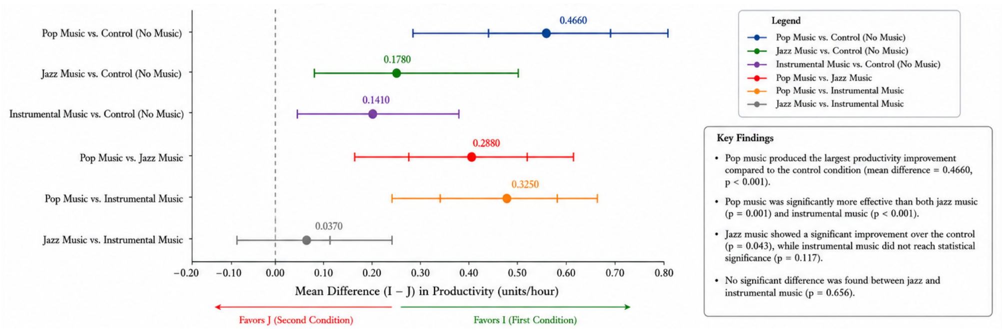

Figure 7. Pairwise comparison of productivity (LSD) post hoc results.

5. Discussion

Contribution to occupational acoustics and sound engineering

The results confirm that music exposure significantly improves productivity during repetitive work activities by increasing output and reducing work cycle time. This finding supports recent occupational acoustics studies indicating that auditory environments influence attention, cognitive performance, and worker efficiency through psychological and physiological mechanisms [5,15,16].

The repeated measures analytical framework strengthens the robustness of the findings because each participant served as his own control across all auditory conditions. Consequently, inter-individual variability associated with skill level, work pace, and personal characteristics was substantially reduced. The large Partial Eta Squared value obtained from the RM-ANOVA further indicates that music exposure exerted not only statistical significance but also substantial practical importance in improving repetitive task productivity.

Pop music produced the highest productivity enhancement (33.82%), suggesting that rhythmic and tempo-based auditory stimulation can improve attentional stability and psychomotor coordination. Similar findings were reported by Park et al. [17] and Martin-Moratinos et al. [18], who demonstrated that structured rhythmic sound enhances neural synchronization and task performance. These findings also strengthen the concept of productive soundscapes in occupational sound engineering. Beyond noise control, engineered auditory environments can function as adaptive acoustic interventions that improve operational performance and reduce mental fatigue [19,20]. The differences observed across music genres further indicate that acoustic parameters such as tempo and rhythmic regularity should be optimized according to task characteristics and cognitive workload in modern industrial environments. While these findings are consistent with previous literature, the present study did not directly measure attentional stability, psychomotor coordination, neural synchronization, arousal, familiarity, or rhythmic anticipation. Therefore, these mechanisms should be considered plausible explanatory hypotheses derived from prior research rather than empirically verified mediators within the current experiment.

From an occupational acoustics perspective, controlled music exposure can function as a positive acoustic intervention that reduces boredom, maintains concentration, and improves cognitive endurance during repetitive tasks. Monotonous work activities are frequently associated with mental fatigue and decreased attentional stability; therefore, auditory stimulation may help sustain worker alertness and emotional engagement. Recent studies in workplace acoustics reported that well-designed sound environments contribute to improved working memory, lower stress levels, and enhanced cognitive performance in occupational settings [21,22].

Among the evaluated conditions, pop music produced the highest productivity increase, indicating that rhythmic intensity, tempo regularity, and musical familiarity play important roles in sustaining work performance. Faster tempo and predictable rhythmic structures may enhance psychomotor synchronization and maintain operational pace during repetitive activities. Similar findings were reported by Sun et al. [4], who demonstrated that rhythm-oriented auditory stimulation improves attentional focus and task execution efficiency. However, variables such as musical familiarity, perceived enjoyment, motivational state, and physiological arousal were not experimentally manipulated or statistically tested. Consequently, the study cannot determine whether these factors mediated the observed productivity differences among music conditions.

Jazz and instrumental music also showed positive productivity effects, although their impacts were comparatively smaller. Instrumental music may support relaxation and concentration by minimizing lyrical distraction, whereas jazz music may provide moderate cognitive stimulation without causing excessive sensory load. This finding suggests that different musical structures generate distinct psychoacoustic responses depending on task characteristics and worker cognitive demands. Overall, the results reinforce the growing concept of productive soundscapes in occupational acoustics, where engineered auditory environments are designed not only to control noise exposure but also to optimize worker performance and psychological well-being. However, it is important to distinguish between descriptive trends and statistically supported effects. While instrumental music exhibited a higher mean productivity value than the control condition, the pairwise comparison did not reach statistical significance ($p = 0.117$). Therefore, the present findings do not provide sufficient statistical evidence to conclude that instrumental music significantly improves productivity relative to the no-music condition; rather, the results indicate only a non-significant positive tendency that warrants further investigation.

The findings are highly relevant to sound and vibration engineering because they demonstrate that workplace sound environments are not inherently detrimental. Although uncontrolled industrial noise is associated with stress, fatigue, and reduced performance, controlled auditory stimuli such as music may generate positive psychoacoustic effects that enhance productivity and worker comfort [23, 24]. This indicates that acoustic environments should be evaluated not only from a noise control perspective but also as strategic components of human-centered productivity optimization. The present results further suggest that acoustic environmental design should be integrated into ergonomics and operational management strategies. Appropriate music selection, sound intensity regulation, and exposure duration management may support attentional stability, reduce perceived monotony, and improve operational efficiency during repetitive tasks. Recent occupational acoustics research has emphasized that adaptive soundscape design can positively influence cognitive performance and psychological well-being in industrial and office environments [25,26]. From an engineering perspective, workplace acoustic environments should not be evaluated solely as sources of occupational noise exposure. Appropriately designed auditory stimulation may function as a controllable environmental parameter influencing attentional stability, psychomotor synchronization, and repetitive task efficiency. Nevertheless, claims regarding the maintenance of a more stable work rhythm should be interpreted cautiously because no direct measurements of psychomotor coordination, rhythmic stability, movement synchronization, or temporal work-pattern consistency were collected. The observed productivity improvements therefore reflect performance outcomes rather than direct evidence of rhythm stabilization mechanisms.

Several limitations should be acknowledged. The study involved controlled repetitive-task simulations using a relatively homogeneous participant group; therefore, the findings should not yet be generalized to all industrial populations or complex cognitive work environments. In addition, acoustic variables such as tempo, sound pressure level, and frequency characteristics were not independently isolated. Future research should incorporate broader industrial populations, physiological measurements, advanced psychoacoustic analysis, and long-term exposure evaluation to strengthen occupational sound-engineering models. Furthermore, acoustic attributes, including lyrical density, spectral distribution, loudness fluctuations, and rhythmic regularity, were controlled to the extent practicable but were not independently manipulated. Therefore, the observed productivity differences cannot be attributed exclusively to music genre, and some residual acoustic confounding may remain. The study also did not formally analyze the influence of demographic characteristics or music preferences on productivity outcomes. Individual differences in age, gender, cultural background, musical familiarity, and genre preference may affect emotional responses, arousal levels, and task engagement during music exposure. Consequently, the findings should be interpreted primarily within the context of the sampled participant group, and broader generalizations to other populations should be made with caution. In addition, although efforts were made to vary the exposure sequence and reduce fatigue, the repeated-measures design may still be susceptible to order, learning, adaptation, or cumulative fatigue effects. Because the present study did not conduct a dedicated statistical assessment of sequencing effects, some portion of the observed productivity differences may reflect residual order-related influences rather than purely the auditory treatments themselves. Another limitation concerns the statistical treatment of repeated observations. Since the same participants were measured across multiple auditory conditions, within-subject correlations may not have been fully accommodated by the one-way ANOVA framework. Future research should apply repeated measures ANOVA or mixed-effects models to obtain more robust estimates and reduce the risk of inflated Type I error rates. In addition, the discussion includes several mechanism-based interpretations informed by previous occupational acoustics and music-performance literature. Because the present study did not include mediation analyses or direct measurements of psychological and physiological processes, causal inferences regarding rhythmic anticipation, musical familiarity, attentional regulation, emotional arousal, or psychomotor synchronization remain speculative and should be validated in future research. An additional limitation concerns the acoustic delivery protocol. Although participants completed the experimental tasks individually, the study did not formally assess the effectiveness of acoustic isolation or quantify the extent to which external auditory interference may have occurred. Furthermore, individual differences in genre preference, prior musical exposure, and music-related attitudes were not measured or incorporated into the statistical analysis. These factors may have influenced emotional responses, motivation, or task engagement and therefore represent potential sources of unexplained variability. Another limitation concerns the characterization of the control sound environment. The study did not continuously monitor or document ambient noise sound pressure levels during the no music condition. As a result, background noise fluctuations over time could not be quantified, and differences observed between auditory conditions may partially reflect variations in overall acoustic energy and spectral characteristics rather than music exposure alone. Future studies should employ calibrated sound level measurements and detailed spectral analysis to isolate the independent effects of music genre, sound pressure level, and acoustic composition. Another limitation relates to the documentation of music selection procedures. Although music genres were chosen based on a preliminary participant preference survey, detailed records of survey responses, preference distributions, questionnaire structure, and final track selection decisions were not retained for publication. Furthermore, individual music tracks within the same genre may differ substantially in rhythmic stability, melodic complexity, lyrical content, familiarity, and psychoacoustic characteristics. Because the complete track list was not reported, the reproducibility of the auditory intervention is reduced, and some track-specific effects cannot be ruled out. Future studies should provide full playlists, track metadata, selection criteria, and acoustic descriptors to facilitate replication and improve comparability across studies. Another limitation concerns the relatively short exposure duration used in each experimental condition. Participants were exposed to each auditory condition for only 20 min, which may not have been sufficient for monotony, mental fatigue, cognitive adaptation, or listening fatigue effects to fully emerge during repetitive work activities. Because no pilot study was conducted to establish the optimal exposure duration, the selection of the 20-minute period was based mainly on operational feasibility and participant-management considerations. Consequently, the present findings primarily represent short-term productivity responses and may not accurately reflect worker performance during prolonged work shifts. Future studies should investigate longer continuous exposure periods, including one-hour, two-hour, or full-shift conditions, to determine whether the observed productivity benefits remain stable, increase, or diminish over time. Another limitation concerns the absence of a blinded experimental design. Participants were fully aware of the auditory condition to which they were exposed, including whether music was present and which genre was being played. As a result, expectancy effects, demand characteristics, and participant beliefs regarding the beneficial effects of music may have influenced productivity outcomes independently of the acoustic stimulus itself. Because no placebo condition, masking procedure, or expectancy measurement instrument was incorporated into the study design, it is not possible to determine the extent to which the observed productivity improvements were attributable to direct psychoacoustic mechanisms versus participant expectations. Future studies should consider single-blind or placebo-controlled auditory protocols, together with expectancy questionnaires, to better isolate the causal effects of music exposure on work performance.

Future research should investigate more diverse worker demographics, including differences in age, gender, occupational background, and cultural exposure to music, because individual auditory responses may vary substantially across populations [27]. In addition, further studies should evaluate various industrial and cognitive task types to determine whether music exposure produces consistent effects across manual, analytical, and decision-making activities.

Long-term exposure effects also require deeper investigation, particularly regarding cognitive adaptation, listening fatigue, and sustained productivity performance over extended operational periods. Recent occupational acoustics research has emphasized that prolonged auditory exposure may generate both beneficial and adverse psychoacoustic responses depending on sound characteristics and exposure duration [28]. Furthermore, future studies should systematically examine music tempo, rhythmic complexity, and sound intensity variations because these acoustic parameters strongly influence attentional control, emotional regulation, and psychomotor synchronization during work activities [29]. Future studies should employ multivariate or mixed-effects models to examine whether demographic characteristics and individual music preferences moderate the relationship between music exposure and productivity performance.

The inclusion of physiological indicators such as heart rate variability, stress hormone response, and neurophysiological monitoring may also strengthen the scientific understanding of how auditory stimulation affects worker performance and mental workload. Integrating psychoacoustic analysis with physiological and ergonomic measurements could provide a more comprehensive framework for occupational sound engineering and human-centered workplace design [30]. Overall, such multidisciplinary investigations would significantly strengthen the integration of acoustics, ergonomics, cognitive engineering, and occupational health research in future industrial applications.

6. Conclusion

This research demonstrates that adaptive acoustic stimulation through music exposure can significantly improve productivity during repetitive industrial tasks. The study introduces a novel interdisciplinary framework combining occupational acoustics, ergonomics, and productivity engineering, expanding the role of sound engineering from passive noise control toward active productivity enhancement through beneficial auditory design.

This study investigated the influence of music genre on productivity during repetitive work activities. The results indicate that:

1) Music significantly affects work productivity.
2) Pop music provides the greatest productivity improvement among the tested genres.
3) Productivity increased by 33.82% under pop music exposure, while jazz and instrumental music increased productivity by 13.03% and 10.45%, respectively.

The findings demonstrate that controlled music exposure may serve as an effective acoustic intervention for improving worker performance in repetitive industrial tasks. The study contributes to occupational sound and vibration research by highlighting the positive role of auditory environmental design in productivity enhancement. Overall, the study demonstrates that engineered auditory environments can positively influence human performance within repetitive industrial systems. The findings support the growing concept of productive soundscapes in occupational acoustics and suggest that sound engineering may contribute not only to worker protection but also to operational performance optimization within human-centered industrial environments. Importantly, only pop music and jazz music demonstrated statistically significant productivity improvements relative to the control condition under the present analytical framework. Instrumental music showed a positive numerical trend but did not differ significantly from the no-music condition (p = 0.117); therefore, its effect should be interpreted cautiously. The applicability of these findings should be interpreted within the specific boundary conditions of the present study. The experiment evaluated short-term music exposure (20-minute sessions) during repetitive and monotonous manual tasks performed under controlled conditions. Therefore, the results should not be directly generalized to long-term exposure scenarios, full industrial work shifts, complex cognitive tasks, and decision-making activities, or heterogeneous worker populations without further empirical validation. While the findings suggest that engineered auditory environments may contribute to productivity enhancement in repetitive task settings, future studies are required to evaluate whether similar benefits persist across different task types, occupational contexts, and prolonged exposure durations. Accordingly, the concept of productivity-oriented acoustic design should currently be regarded as a promising application for repetitive industrial work rather than a universally established solution for all workplace environments.

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Institutional review board statement: Ethical review and approval were waived for this study because it involved non-invasive research conducted in an occupational setting to evaluate the effects of music on work productivity. The study did not involve medical interventions, clinical procedures, biological sample collection, or sensitive personal data. Participation was voluntary, informed consent was obtained from all participants, confidentiality was maintained throughout the study, and the research complied with the ethical principles of the Declaration of Helsinki.

Informed consent statement: Informed consent was obtained from all subjects involved in the study prior to data collection. Before participation, all respondents were informed about the objectives and procedures of the study, the voluntary nature of their participation, the confidentiality of the collected data, and their right to withdraw from the study at any time without any consequences. No personally identifiable information was collected or disclosed, and all data were analyzed anonymously.

Data availability statement: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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AI use statement: During the preparation of this manuscript, the authors used generative artificial intelligence (AI) tools [GBT-5.6 Sol] solely for language refinement. No AI tools were used for data analysis, interpretation, or generation of scientific content. All outputs were critically reviewed and edited by the authors. The authors take full responsibility for the integrity and accuracy of the work.

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