Leeds Doctoral College
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Title: {The Impact of Digital Transformation on Performance and the Cultural Industry: Challenges and Opportunities}

Research LAB

PhD research proposal

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June 20, 2024

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Submitted for the Faculty of Art Humanities and Cultures

1 INTRODUCTION

This document is enhanced to better reflect the detailed research process, methodology, and significance of digital transformation in the cultural industry. It emphasizes the need for comprehensive analysis and offers a clear structure to guide the reader through the study's objectives, challenges, and expected outcomes.

The cultural industry, encompassing arts, entertainment, and heritage sectors, has undergone significant changes due to digital transformation. The infusion of digital technologies such as artificial intelligence (AI), big data, and the Internet of Things (IoT) has reshaped how cultural products are created, distributed, and consumed. This study focuses on evaluating the impact of digital transformation on performance within the cultural industry, identifying associated challenges, and exploring emerging opportunities.

2 PROBLEM STATEMENT

While the potential benefits of digital transformation in the cultural industry are substantial, understanding its full impact on performance remains underexplored. This research addresses the problem of assessing how digital technologies affect the efficiency, effectiveness, and overall performance of cultural organizations. The challenge lies in quantifying these impacts and understanding the nuanced ways in which digital transformation influences cultural production and consumption.

3 REVIEW OF THE RELATED WORK

The cultural industry: also known as the creative industry, encompasses businesses and activities that produce, create, distribute, and commercialize creative content and cultural products (Gershuny *et al.*, 2011) (European Commission, 2010) (Hesmondhalgh and Pratt, 2005).

Digital transformation (DT): is the process by which an organization adopts and implements digital technology to create new or modify existing products, services, and operations by converting business processes into a digital format (Reischauer, 2022) (Vial, 2019) (Warner and Wäger, 2019).

Figure 1 Diagram for the digital transformation of the cultural industry
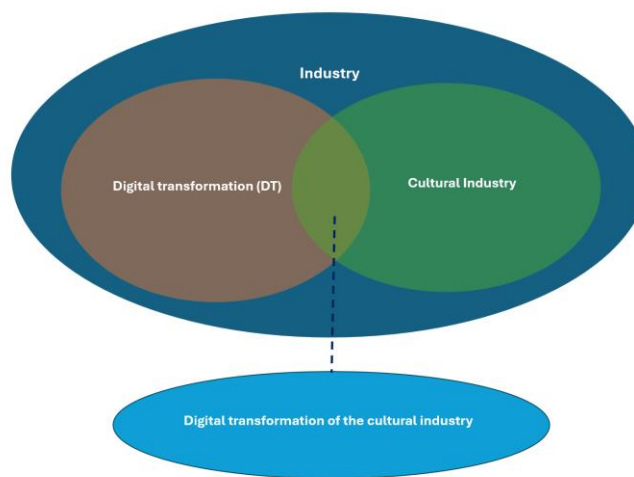
Digital transformation cultural industry is a cultural industry involves the process by which organizations in this sector adopt and implement digital technology to create new or modify existing products, services, and operations by converting business processes into a digital format [J. Heider 2024]. We will use this definition in our qualitative data analysis to identify cases relevant to the study.

3.1 PREVIOUS STUDIES ON DIGITAL TRANSFORMATION

Digital transformation has become a significant topic of interest across various industries, including the financial service industry, oil and gas sector, automotive industry, and food retail industry.

- Study 1: (Dehnert, 2020) highlights the importance of understanding how digital transformation dimensions are connected to firm performance, with contradictory findings in existing research.

- Study 2: (Affonso *et al.*, 2020) emphasize the need for innovation in the oil and gas industry, pointing out the risk-averse approach of traditional project management as a hindrance to progress.

- Study 3: (Llopis-Albert, Rubio and Valero, 2021) utilize fuzzy-set qualitative comparative analysis to analyze the impact of digital transformation on business performance models in the automotive industry.

- Study 4: In the context of the banking sector, (Naimi-Sadigh, Asgari and Rabiei, 2022) discuss the implementation of digital transformation to respond to disruptions and drive innovation in banking services.

- Study 5: (Manjula, Balaji and Deepa, 2021) focus on digital technologies in the food retail industry, identifying challenges and opportunities in the digital transformation process.

- Study 6: (Imran *et al.*, 2021) explore digital transformation in industrial organizations, aiming to identify key enablers and performance outcomes through data collected from leading industrial organizations.

- Study 7: (Kumar *et al.*, 2022) propose a framework for assessing the social acceptability of Industry 4.0 technologies in digital manufacturing, highlighting the importance of considering social dimensions in technological advancements.

- Study 8: (Ren, Li and Liang, 2023) shed light on the impact of digital transformation on renewable energy companies' performance in China, emphasizing the role of digital transformation in advancing the development of renewable energy enterprises.

- Study 9: (Zhao *et al.*, 2023) analyze the relationship between digital transformation strategy and ESG performance in large manufacturing enterprises, focusing on the mediating role of green innovation and sustainable development goals.

- Study 10: (Sartal *et al.*, 2020). Overall, the literature review indicates a growing interest in understanding the impact of digital transformation on performance across various industries, highlighting both challenges and opportunities that come with embracing digital technologies.

The need for innovation, strategic alignment, and the identification of key enablers in the digital transformation process are recurring themes in the literature, emphasizing the importance of leveraging digital technologies to drive organizational success.

3.2 LOCATING CASE STUDIES WITHIN CULTURAL INDUSTRIES

These examples illustrate the diversity and richness of cultural industries, highlighting their economic and cultural significance.

1. **Music Industry** (Negus, 1999):
   o Involves the production, distribution, and consumption of music. This includes recording, live performances, and music publishing.
   o Example: Major record labels like Universal Music Group and independent artists producing and distributing their music through digital platforms like Spotify.

2. **Film and Television Industry** (Hesmondhalgh, 2013):
   o Includes the production and distribution of films, TV shows, and other video content.
   o Example: Hollywood studios such as Warner Bros. and streaming platforms like Netflix and Hulu.

3. **Publishing Industry** (Hjarvard, 2011):
   o Encompasses the production and distribution of books, magazines, newspapers, and digital publications.
   o Example: Major publishing houses like Penguin Random House and digital self-publishing platforms like Amazon Kindle Direct Publishing.

4. **Fashion Industry** (Crane, 2012):
   o Involves the design, production, marketing, and retail of clothing, footwear, and accessories.
   o Example: High fashion brands like Gucci and fast fashion retailers like Zara.

5. **Video Game Industry** (Kerr, 2006):
   o Encompasses the development, marketing, and sales of video games and gaming consoles.
   o Example: Major game developers like Electronic Arts (EA) and indie game developers distributing through platforms like Steam.

6. **Advertising Industry** (McFall, 2004):
   o Involves the creation and dissemination of advertisements and marketing campaigns.
   o Example: Global advertising agencies like WPP and digital marketing firms specializing in social media and online advertising.

7. **Art and Antiques Market** (Velthuis, 2005):
   o Includes the creation, exhibition, and sale of visual arts, crafts, and antiques.
   o Example: Art galleries like Gagosian Gallery and auction houses like Sotheby's.

8. **Architecture and Design** (Jencks, 2000):
   o Encompasses the design of buildings, interior spaces, and urban environments.
   o Example: Renowned architecture firms like Foster + Partners and freelance interior designers.

9. **Performing Arts** (Collins and Nisbet, 2010):
   o Involves live performances of drama, dance, opera, and music.
   o Example: Prestigious venues like the Royal Opera House and Broadway theaters.

10. **Crafts and Handmade Goods** (Luckman, 2015):
    o Encompasses the creation and sale of handmade items such as pottery, jewelry, and textiles.
    o Example: Online marketplaces like Etsy and local craft fairs.

3.3 EXPLORING CHALLENGES, OPPORTUNITIES, AND PERFORMANCE IN CULTURAL INDUSTRIES: A COMPREHENSIVE STUDY REVIEW

3.3.1 Challenges

1. **Digital Divide**: The digital divide can hinder access to digital technologies and platforms, creating barriers for those who are less tech-savvy or have limited resources (Koshelieva *et al.*, 2023) (European Commission, 2022).

2. **Copyright and Intellectual Property**: The use of digital technologies raises concerns about copyright and intellectual property, particularly in the context of digital assets and data management (valantic, 2024) (European Commission, 2022).

3. **Preservation of Cultural Heritage**: The digitization of cultural heritage poses challenges related to preservation, conservation, and the long-term accessibility of digital artifacts (Koshelieva *et al.*, 2023) (Massi, Vecco and Lin, 2020).

4. **Organizational Barriers**: The adoption of digital tools and processes can be hindered by organizational silos and a lack of understanding of the value of data (valantic, 2024).

3.3.2 Opportunities

1. **New Forms of Cultural Expression**: Digital technologies have enabled new forms of artistic expression, such as AR/VR, and have opened up new channels for cultural consumption and engagement (Koshelieva *et al.*, 2023) (valantic, 2024).

2. **Increased Accessibility**: Digital platforms have increased access to art and culture, making it more inclusive and global (Koshelieva *et al.*, 2023) .

3. **Collaboration and Networking**: Digital tools facilitate global collaboration and networking among artists, institutions, and audiences (valantic, 2024) (Massi, Vecco and Lin, 2020).

4. **Efficient Processes**: Digital transformation can streamline administrative processes, reducing errors and improving employee satisfaction (valantic, 2024).

3.3.3 Performances

1. **Data Interoperability**: Ensuring data interoperability is crucial for seamless end-to-end processes and for addressing copyright and intellectual property concerns (European Commission, 2022).

2. **Digital Literacy**: Developing digital literacy among artists, institutions, and audiences is essential for effective adoption and utilization of digital technologies (valantic, 2024) (European Commission, 2022).

3. **Collaborative Ecosystems**: Fostering collaborative ecosystems between tech startups and creative sectors can facilitate knowledge exchange and innovation (European Commission, 2022).

4. **Digital Sovereignty**: Establishing digital sovereignty through strategic policies and regulations can ensure the long-term sustainability and accessibility of digital cultural assets (Massi, Vecco and Lin, 2020).

Overall, the impact of digital transformation cultural and creative industries is complex, presenting both challenges and opportunities. By understanding these dynamics and implementing effective strategies, the industry can harness the potential of digital technologies to enhance cultural expression, accessibility, and collaboration.

3.4 GAP IN LITERATURE

The current literature lacks a holistic analysis of the relationship between digital transformation and performance metrics in the cultural industry. Most studies focus on individual aspects such as technology adoption or economic impacts, but few provide an integrated view that includes challenges and opportunities across the sector.

3.5 SIGNIFICANCE

Addressing this gap is crucial for policymakers, cultural managers, and stakeholders to make informed decisions that foster sustainable growth in the cultural sector. Understanding the impact of digital transformation on performance can guide strategic investments, enhance cultural policy frameworks, and support the development of adaptive strategies for cultural organizations.

3.6 RESEARCH QUESTIONS

Research questions for the title "The Impact of Digital Transformation on Performance and the Cultural Industry: Challenges and Opportunities" could include:

RQ1: Performance
- What digital transformation factors enhance the efficiency and effectiveness of cultural institutions?
- What types of performance are impacted by digital transformation in the cultural industry?

RQ2: Challenges:
- What are the key challenges faced by cultural institutions in adopting digital transformation?

RQ3: Opportunities:
- What digital transformation factors enhance diversity and equal opportunity in the cultural industry?

4 METHODOLOGY

This research methodology provides a comprehensive approach to exploring the multifaceted impacts of digital transformation in cultural institutions, combining qualitative and quantitative methods to yield robust and actionable insights. Here's a detailed data collection and data analysis plan for the research questions:

Research Questions

RQ1: Performance
- What digital transformation factors enhance the efficiency and effectiveness of cultural institutions?
- What types of performance are impacted by digital transformation in the cultural industry?

RQ2: Challenges
- What are the key challenges faced by cultural institutions in adopting digital transformation?

RQ3: Opportunities
- What digital transformation factors enhance diversity and equal opportunity in the cultural industry?

4.1 DATA COLLECTION PLAN

4.1.1 RQ1: Performance

Qualitative Data Collection:

1. **Interviews with Experts:**
   - **Participants:** Managers, directors, and IT leaders in cultural institutions.
   - **Questions:**
     - What specific digital transformation initiatives have you implemented?
     - How have these initiatives enhanced efficiency and effectiveness?
     - What types of performance improvements have you observed?
2. **Case Studies:**
   - **Sources:** Case studies of cultural institutions that have undergone digital transformation.
   - **Focus:** Documented evidence of performance enhancements.
3. **Focus Groups:**
   - **Participants:** Employees and patrons of cultural institutions.
   - **Topics:**
     - Perceptions of digital transformation's impact on performance.

Quantitative Data Collection:

1. **Surveys:**
   - **Participants:** Cultural institutions.
   - **Questions:**
     - Which digital transformation factors have you implemented?
     - Rate the impact of these factors on efficiency and effectiveness (scale of 1-5).
     - What performance metrics have shown improvement post-implementation?
2. **Performance Metrics Analysis:**
   - **Data:** Visitor numbers, revenue, social media engagement, online ticket sales pre- and post-digital transformation.
3. **Comparative Studies:**
   - **Data:** Performance metrics from institutions with and without digital transformation.

4.1.2 RQ2: Challenges

Qualitative Data Collection:

1. **Interviews with Stakeholders:**
   - o **Participants:** IT staff, management, front-line employees.
   - o **Questions:**
     - ▪ What challenges did you encounter during the digital transformation process?
     - ▪ How did these challenges impact the institution?
2. **Thematic Analysis of Reports:**
   - o **Sources:** Reports from cultural institutions detailing digital transformation challenges.
3. **Focus Groups:**
   - o **Participants:** Employees.
   - o **Topics:**
     - ▪ Common challenges and barriers.

Quantitative Data Collection:

1. **Surveys:**
   - o **Participants:** Cultural institutions.
   - o **Questions:**
     - ▪ What were the most significant challenges you faced during digital transformation? (list possible challenges)
     - ▪ Rate the severity of each challenge (scale of 1-5).
2. **Statistical Analysis:**
   - o **Data:** Frequency and severity of reported challenges.
3. **Benchmarking:**
   - o **Data:** Compare challenge data with institutions in other sectors.

4.1.3 RQ3: Opportunities

Qualitative Data Collection:

1. **Interviews with Leaders in Diversity:**
   - o **Participants:** Diversity officers, leaders in diversity initiatives.
   - o **Questions:**
     - ▪ What digital transformation initiatives have enhanced diversity and equal opportunity?
     - ▪ Can you provide specific examples of how these initiatives have worked?
2. **Document Analysis:**
   - o **Sources:** Diversity and inclusion reports from cultural institutions.
3. **Focus Groups:**
   - o **Participants:** Employees from diverse backgrounds.
   - o **Topics:**
     - ▪ Experiences and insights on digital transformation's impact on diversity.

Quantitative Data Collection:

1. **Surveys:**
   - o **Participants:** Employees and management in cultural institutions.
   - o **Questions:**

- Which digital transformation factors have contributed to enhancing diversity and equal opportunity? (list factors)
- Rate the impact of these factors on a scale of 1-5.
- Have you noticed an increase in diversity metrics since implementing digital transformation initiatives?

2. **Diversity Metrics Analysis:**
   - o **Data:** Gender diversity, ethnic diversity, and inclusion metrics pre- and post-digital transformation.
3. **Comparative Analysis:**
   - o **Data:** Diversity and inclusion metrics before and after digital transformation.

4.2   DATA ANALYSIS PLAN

4.2.1   RQ1: Performance

Qualitative Data Analysis:

1. **Transcription:** Transcribe interviews and focus group discussions.
2. **Coding:** Use NVivo[1] or Atlas.ti[2] to code transcripts for themes related to efficiency, effectiveness, and performance impacts.
3. **Thematic Analysis:** Identify and categorize themes such as improved operational efficiency, enhanced visitor engagement, and increased revenue.
4. **Content Analysis:** Analyze case studies for examples of digital transformation impacts.

Quantitative Data Analysis (Appendix):

1. **Descriptive Statistics:** Summarize survey responses (means, medians, modes).
2. **Inferential Statistics:** Use t-tests[3] or ANOVA[4] to compare performance metrics before and after digital transformation.
3. **Correlation Analysis:** Explore relationships between digital transformation factors and performance outcomes.
4. **Trend Analysis:** Conduct trend analysis of performance metrics over time using line graphs.
5. **Benchmarking:** Compare performance metrics of institutions with and without digital transformation using bar charts or scatter plots.

4.2.2   RQ2: Challenges

Qualitative Data Analysis:

1. **Transcription and Coding:** Transcribe and code data for themes related to challenges.
2. **Thematic Analysis:** Identify key challenges and categorize them into broader themes.
3. **Frequency Analysis:** Analyze the frequency of different challenges mentioned.

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[1] https://lumivero.com/products/nvivo/

[2] https://atlasti.com/

[3] https://drive.google.com/file/d/1-IGnUbP8F3gWTFzap1s-ZEiTuUI_fY98/view?usp=sharing

[4] https://colab.research.google.com/drive/1-Q672tb7HZAU_u7HoVtsZ4plsrDS8QU-

Quantitative Data Analysis:

1. **Descriptive Statistics:** Summarize survey data (frequency and severity of challenges).
2. **Cluster Analysis:** Group institutions based on types and severity of challenges faced.
3. **Comparative Analysis:** Compare challenge data across different types of cultural institutions.

4.2.3   RQ3: Opportunities

Qualitative Data Analysis:

1. **Transcription and Coding:** Transcribe and code data for themes related to diversity and equal opportunity enhancements.
2. **Thematic Analysis:** Identify opportunities and categorize them into themes.
3. **Content Analysis:** Analyze diversity and inclusion reports for relevant examples.

Quantitative Data Analysis:

1. **Descriptive Statistics:** Summarize survey responses (impact ratings of digital transformation factors).
2. **Correlation Analysis:** Explore correlations between digital transformation initiatives and diversity metrics.
3. **Regression Analysis:** Predict the impact of specific digital transformation factors on diversity outcomes.
4. **Comparative Analysis:** Compare diversity metrics before and after digital transformation using paired t-tests.
5. **Visualization:** Use bar charts, pie charts, and scatter plots to visualize diversity data and the impact of digital transformation initiatives.

By following this data collection and analysis plan, I will be able to systematically gather and analyze data to answer your research questions on the performance, challenges, and opportunities related to digital transformation in cultural institutions.

5 EXPECTED OUTCOMES

Here are the expected results for each the research questions based on the data collection and analysis plan. These expected results are hypothetical and provide a general direction of findings that might emerge from the research.

5.1 RESEARCH QUESTION 1: PERFORMANCE

Expected Qualitative Results:

1. **Enhanced Efficiency:**
   - **Themes:** Streamlined operations, faster decision-making, reduced manual tasks.
   - **Examples:** Automated ticketing systems, digital archives for easier access to collections, real-time data analytics for resource allocation.
2. **Improved Effectiveness:**
   - **Themes:** Better visitor engagement, enhanced educational programs, improved content delivery.
   - **Examples:** Interactive digital exhibits, virtual reality tours, online educational workshops.
3. **Types of Performance Impacted:**
   - **Themes:** Visitor satisfaction, revenue growth, operational cost savings.
   - **Examples:** Increased visitor numbers due to engaging digital experiences, higher online ticket sales, reduced costs through digital marketing.

Expected Quantitative Results:

1. **Survey Data:**
   - **Descriptive Statistics:** High ratings for factors like automation, digital marketing, and online engagement on efficiency and effectiveness scales (average ratings of 4+ on a 5-point scale).
   - **Inferential Statistics:** Significant improvement in KPIs such as visitor numbers ($p < 0.05$), revenue ($p < 0.05$), and engagement metrics post-digital transformation.
2. **Performance Metrics Analysis:**
   - **Trend Analysis:** Positive trends in visitor numbers, revenue, and social media engagement post-digital transformation.
   - **Benchmarking:** Institutions with digital transformation initiatives showing 20-30% higher performance metrics compared to those without.

5.2 RESEARCH QUESTION 2: CHALLENGES

Expected Qualitative Results:

1. **Key Challenges Identified:**
   - **Themes:** Technological barriers, funding constraints, resistance to change, skill gaps.
   - **Examples:** Difficulty in integrating new technologies with legacy systems, limited budgets for digital initiatives, reluctance among staff to adopt new processes.
2. **Impact of Challenges:**
   - **Themes:** Delays in implementation, increased costs, reduced staff morale.
   - **Examples:** Extended project timelines due to technical issues, higher training costs, lower employee engagement due to resistance to change.

Expected Quantitative Results:

1. **Survey Data:**

- o **Descriptive Statistics:** High frequency and severity ratings for challenges such as technological integration (average severity rating of 4+ on a 5-point scale) and funding issues.
- o **Cluster Analysis:** Groups of institutions facing similar sets of challenges, e.g., smaller institutions facing more severe funding issues compared to larger ones.
- o **Comparative Analysis:** Museums reporting more technological barriers compared to theaters, which report more resistance to change.

5.3 RESEARCH QUESTION 3: OPPORTUNITIES

Expected Qualitative Results:

1. **Enhanced Diversity and Equal Opportunity:**
   - o **Themes:** Inclusive digital content, accessible platforms, diverse hiring practices.
   - o **Examples:** Multilingual websites, online exhibits highlighting diverse cultures, remote work opportunities increasing staff diversity.
2. **Specific Initiatives:**
   - o **Themes:** Programs promoting diversity, training for inclusive practices, partnerships with diverse communities.
   - o **Examples:** Digital storytelling projects with underrepresented groups, inclusive design workshops for staff, collaborations with community organizations.

Expected Quantitative Results:

1. **Survey Data:**
   - o **Descriptive Statistics:** Positive ratings for factors enhancing diversity and equal opportunity (average ratings of 4+ on a 5-point scale).
   - o **Correlation Analysis:** Strong positive correlations ($r > 0.5$) between digital transformation initiatives and improvements in diversity metrics.
   - o **Regression Analysis:** Digital initiatives explaining a significant portion of the variance in diversity outcomes ($R^2 > 0.4$).
2. **Diversity Metrics Analysis:**
   - o **Comparative Analysis:** Significant increases in diversity metrics (e.g., gender diversity, ethnic diversity) post-digital transformation ($p < 0.05$).
   - o **Visualization:** Clear upward trends in diversity and inclusion metrics illustrated through bar charts and scatter plots.

5.4 SUMMARY OF EXPECTED RESULTS

1. **Performance:** digital transformation enhances both efficiency and effectiveness of cultural institutions, leading to improved visitor engagement, revenue growth, and operational cost savings.

2. **Challenges:** key challenges include technological barriers, funding constraints, resistance to change, and skill gaps. These challenges can delay implementation, increase costs, and reduce staff morale.

3. **Opportunities:** digital transformation offers significant opportunities to enhance diversity and equal opportunity through inclusive digital content, accessible platforms, and diverse hiring practices. These initiatives positively impact diversity metrics and foster a more inclusive cultural environment.

These expected results provide a hypothetical overview of what the research might uncover, guiding the direction and focus of your data collection and analysis efforts.

6 TIMESCALE FOR RESEARCH PROJECT

Here is a detailed three-year timescale for the research project on digital transformation in cultural institutions, broken down into quarterly segments.

6.1 YEAR 1

6.1.1 Q1 (Months 1-3)

1. **Project Planning and Preparation:**
   o Define research objectives and scope.
   o Develop detailed research methodology.
   o Identify and recruit research team members.
   o Secure funding and necessary approvals.
   o Develop data collection instruments (interview guides, survey questionnaires).
2. **Literature Review:**
   o Conduct a comprehensive review of existing literature on digital transformation in cultural institutions.
   o Identify key themes and gaps in the current research.

6.1.2 Q2 (Months 4-6)

1. **Pilot Testing:**
   o Conduct pilot interviews and surveys to refine data collection instruments.
   o Adjust methodology based on pilot feedback.
2. **Data Collection – Phase 1 (Qualitative):**
   o Begin conducting interviews with managers, directors, IT leaders, and diversity officers in cultural institutions.
   o Collect case studies and relevant documents.
   o Organize and conduct initial focus groups.

6.1.3 Q3 (Months 7-9)

1. **Data Collection – Phase 1 (Qualitative) Continued:**
   o Continue conducting interviews and focus groups.
   o Complete document analysis and case study reviews.
2. **Preliminary Data Analysis – Qualitative:**
   o Transcribe and code initial qualitative data.
   o Begin thematic analysis to identify emerging patterns and themes.

6.1.4 Q4 (Months 10-12)

1. **Data Collection – Phase 2 (Quantitative):**
   o Develop and distribute surveys to a broad range of cultural institutions.
   o Collect performance metrics and diversity metrics data from participating institutions.
2. **Data Collection – Ongoing Monitoring:**
   o Monitor data collection process for completeness and accuracy.
   o Address any issues or gaps in data collection.

6.2 YEAR 2

6.2.1.1 Q1 (Months 13-15)

1. **Data Collection – Phase 2 (Quantitative) Continued:**
   - o Continue collecting survey responses and performance metrics.
   - o Begin initial data cleaning and preparation for analysis.
2. **Qualitative Data Analysis:**
   - o Complete transcription and coding of all qualitative data.
   - o Finalize thematic analysis and identify key findings.

6.2.1.2 Q2 (Months 16-18)

1. **Quantitative Data Analysis – Initial Phase:**
   - o Conduct descriptive statistics and basic inferential analyses (t-tests, ANOVA) on survey data.
   - o Begin correlation and regression analyses to explore relationships between variables.
2. **Integration of Qualitative and Quantitative Data:**
   - o Compare qualitative themes with quantitative findings.
   - o Identify areas of convergence and divergence.

6.2.1.3 Q3 (Months 19-21)

1. **Quantitative Data Analysis – Advanced Phase:**
   - o Complete all statistical analyses, including cluster and trend analyses.
   - o Finalize performance metrics and diversity metrics comparisons.
2. **Prepare Interim Report:**
   - o Summarize initial findings from both qualitative and quantitative data.
   - o Identify any additional data needs or follow-up research.

6.2.1.4 Q4 (Months 22-24)

1. **Dissemination of Preliminary Findings:**
   - o Present interim findings at academic conferences or industry seminars.
   - o Gather feedback from peers and stakeholders.
2. **Refinement and Additional Data Collection (if needed):**
   - o Address any gaps or weaknesses in the data.
   - o Conduct follow-up interviews or surveys as necessary.

6.3 YEAR 3

6.3.1 Q1 (Months 25-27)

1. **Comprehensive Data Analysis:**
   - o Reassess and refine analyses based on feedback and additional data.
   - o Integrate all findings into a cohesive framework.
2. **Preparation of Final Report:**
   - o Begin drafting the final report, including all sections (introduction, literature review, methodology, results, discussion, conclusions).

6.3.2 Q2 (Months 28-30)

1. **Final Report Writing:**
   - o Continue drafting and refining the final report.

   o Ensure all data is accurately represented and thoroughly analyzed.

2. **Review and Revision:**
   o Circulate the draft report to key stakeholders and research team members for feedback.
   o Revise the report based on feedback received.

6.3.3 Q3 (Months 31-33)

1. **Final Report Completion:**
   o Finalize the report, ensuring all sections are complete and well-integrated.
   o Prepare visual aids (charts, graphs) for key findings.
2. **Preparation for Dissemination:**
   o Develop a dissemination plan (academic publications, industry reports, presentations).
   o Prepare summaries and press releases for broader audiences.

6.3.4 Q4 (Months 34-36)

1. **Dissemination of Findings:**
   o Submit the final report to funding bodies and stakeholders.
   o Publish findings in academic journals and present at conferences.
   o Distribute reports to participating institutions and relevant industry bodies.
2. **Project Evaluation and Wrap-Up:**
   o Conduct a project debrief with the research team to evaluate outcomes and processes.
   o Identify lessons learned and potential areas for future research.
   o Finalize all administrative and financial aspects of the project.

By following this detailed three-year timescale, I will ensure a structured and systematic approach to the research project, allowing me to thoroughly explore the performance, challenges, and opportunities associated with digital transformation in cultural institutions.

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APPENDIX

Leeds Doctoral College - University of Leeds
Quantitative Data Analysis
T-Test: One-sample t-test , Two-sample t-test, Paired t-test , and Welch's t-test in Python
https://colab.research.google.com/drive/1-IGnUbP8F3gWTFzap1s-ZEiTuUI_fY98
By Heider Jeffer

```python
# Leeds Doctoral College - University of Leeds
# Quantitative Data Analysis with Python
# By Heider Jeffer
# June 20, 2024

# One-sample t-test example in Python

import numpy as np
from scipy import stats

# Population Mean
mu = 10

# Sample Size
N1 = 21

# Degrees of freedom
dof = N1 - 1

# Generate a random sample with mean = 11 and standard deviation = 1
x = np.random.randn(N1) + 11

# Using the Stats library, compute t-statistic and p-value
t_stat, p_val = stats.ttest_1samp(a=x, popmean = mu)
print("t-statistic = " + str(t_stat))
print("p-value = " + str(p_val))
```

```
t-statistic = 3.2806238272741637
p-value = 0.0037389287836883793
```

```python
# Plot One-sample t-test example in Python by Heider Jeffer
# Compute the t-statistic and p-value,
# and then plot the sample distribution
# along with the t-distribution for visualization

import numpy as np
import matplotlib.pyplot as plt
from scipy import stats

# Population Mean
mu = 10

# Sample Size
N1 = 21

# Generate a random sample with mean = 11 and standard deviation = 1
np.random.seed(0)  # Set seed for reproducibility
x = np.random.randn(N1) + 11

# Using the Stats library, compute t-statistic and p-value
t_stat, p_val = stats.ttest_1samp(a=x, popmean=mu)
print("t-statistic = " + str(t_stat))
print("p-value = " + str(p_val))

# Plot the sample distribution and t-distribution
plt.figure(figsize=(12, 6))

# Plot sample distribution
plt.subplot(1, 2, 1)
plt.hist(x, bins=10, edgecolor='black', alpha=0.7)
plt.axvline(np.mean(x), color='r', linestyle='dashed', linewidth=1)
plt.title('Sample Distribution')
plt.xlabel('Sample Values')
plt.ylabel('Frequency')

# Plot t-distribution with sample t-statistic
plt.subplot(1, 2, 2)
x_vals = np.linspace(-4, 4, 1000)
t_dist = stats.t.pdf(x_vals, df=N1-1)
plt.plot(x_vals, t_dist, label='t-distribution')
plt.axvline(t_stat, color='r', linestyle='dashed', linewidth=1, label=f't-statistic = {t_stat:.2f}')
plt.title('t-Distribution')
plt.xlabel('t')
plt.ylabel('Probability Density')
plt.legend()

plt.tight_layout()
plt.show()
```
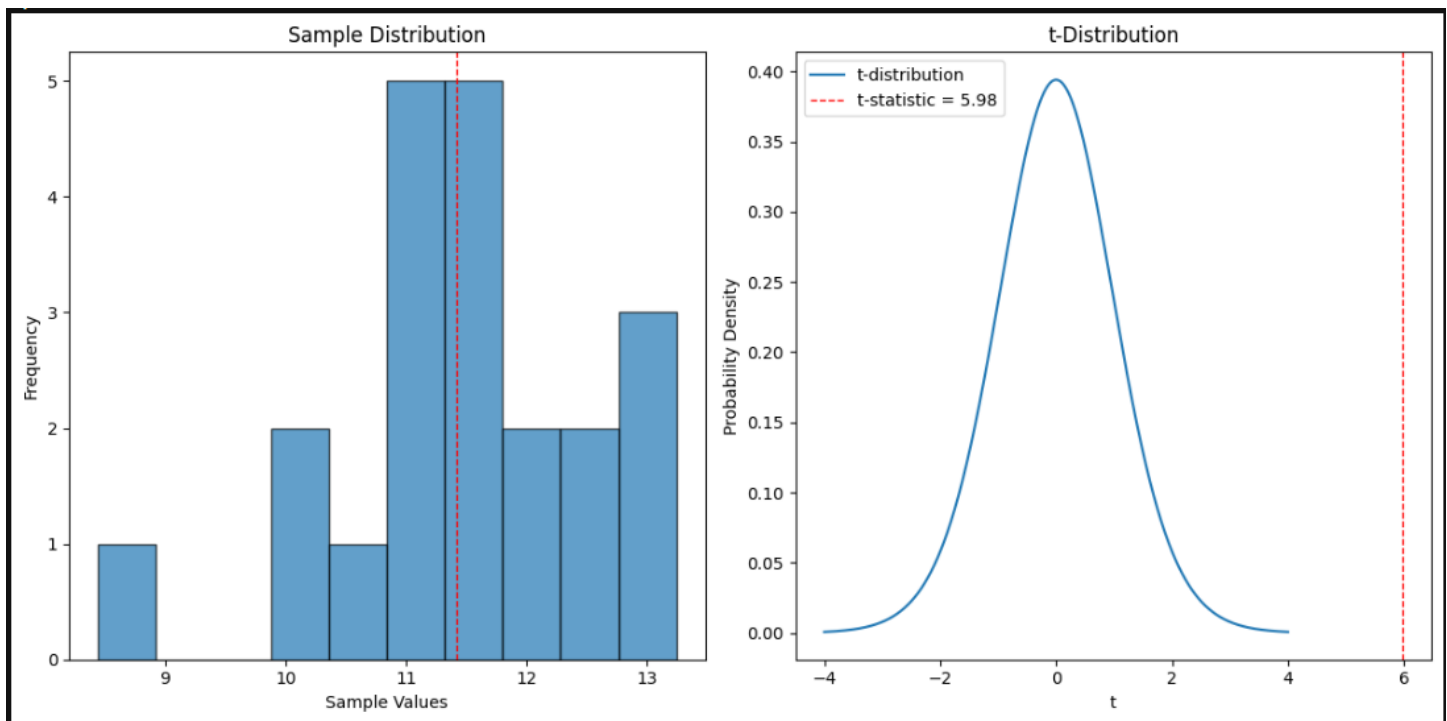
```
t-statistic = 5.9753587422612915
p-value = 7.646525308171602e-06
```

Sample Distribution / t-Distribution

```
A different approach
1. compute the sample mean (x_bar)
2. ompute the sample standard deviation with the degree of freedom of one (it represents the standard deviation of the sample
3. Compute the standard error
4. Use the one-sample t-statistic formula above
5. Compute the p-value to establish the significance of the t-statistic.


Sample Mean
bar = x.mean()

Standard Deviation
d = np.std(x, ddof=1)

Standard Error
e = std/np.sqrt(N1)

Calculating the T-Statistics
stat = (x_bar - mu) / ste

p-value of the t-statistic
val = 2*(1 - stats.t.cdf(abs(t_stat), df = dof))
int("t-statistic = " + str(t_stat))
int("p-value = " + str(p_val))
```

```
t-statistic = 3.8068345338354854
p-value = 0.0011047641393842067
```

```python
# Calculate the Welch's t-test and plot the distributions of the two samples to generate the plots
# Run this code in Python  to visualize the distributions of the two samples.
# This will help you see the overlap and understand
# why the p-value is high, indicating no significant difference between the means.
# by Heider Jeffer

import numpy as np
import matplotlib.pyplot as plt
from scipy import stats

# Sample Sizes
N1, N2 = 21, 25

# Degrees of freedom
dof = min(N1, N2) - 1

# Gaussian distributed data with mean = 9.9 and var = 1
np.random.seed(0)  # Set seed for reproducibility
x = np.random.randn(N1) + 9.9

# Gaussian distributed data with mean = 10 and var = 3
y = 3 * np.random.randn(N2) + 10

# Using SciPy Package
t_stat, p_val = stats.ttest_ind(x, y, equal_var=False)
print("t-statistic = " + str(t_stat))
print("p-value = " + str(p_val))

# Plot the sample distributions
plt.figure(figsize=(12, 6))

# Plot distribution of x
plt.subplot(1, 2, 1)
plt.hist(x, bins=10, edgecolor='black', alpha=0.7, color='blue', label='Sample x')
plt.axvline(np.mean(x), color='r', linestyle='dashed', linewidth=1, label=f'Mean x = {np.mean(x):.2f}')
plt.title('Sample Distribution of x')
plt.xlabel('Sample Values')
plt.ylabel('Frequency')
plt.legend()

# Plot distribution of y
plt.subplot(1, 2, 2)
plt.hist(y, bins=10, edgecolor='black', alpha=0.7, color='green', label='Sample y')
plt.axvline(np.mean(y), color='r', linestyle='dashed', linewidth=1, label=f'Mean y = {np.mean(y):.2f}')
plt.title('Sample Distribution of y')
plt.xlabel('Sample Values')
plt.ylabel('Frequency')
plt.legend()

plt.tight_layout()
plt.show()
```
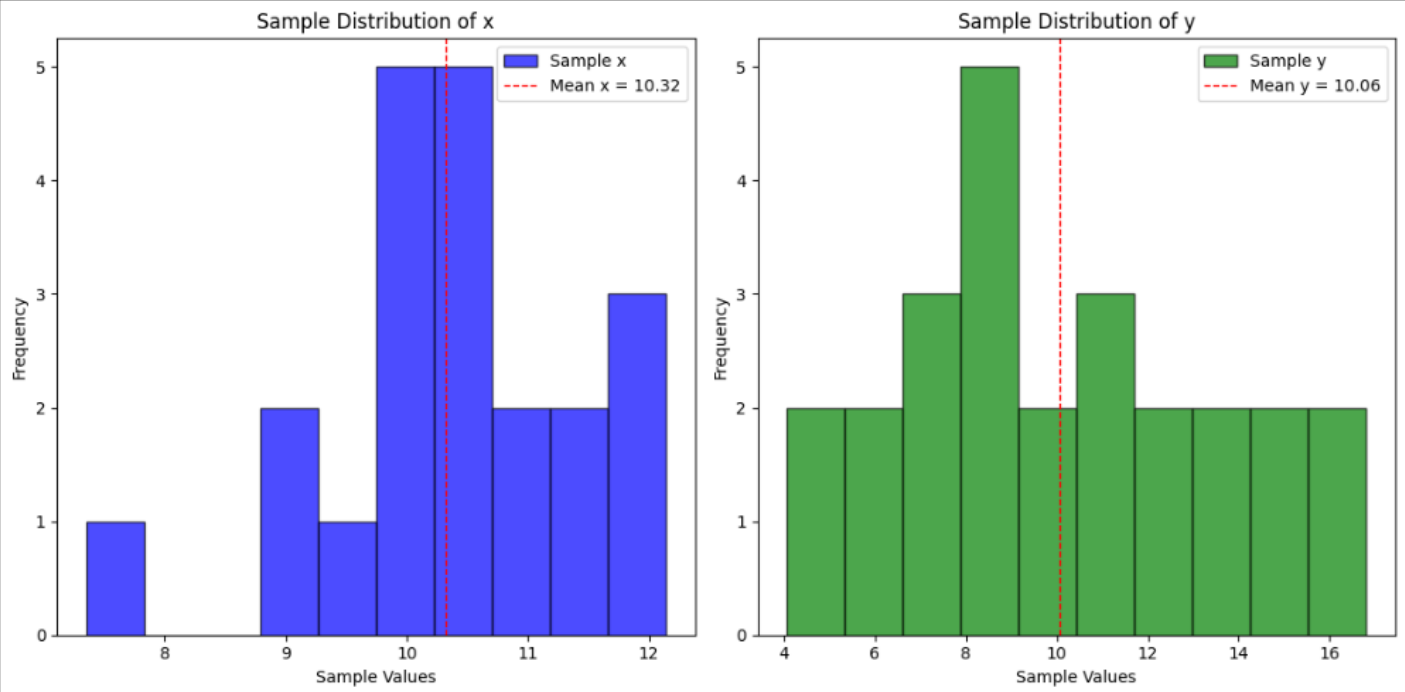
```
t-statistic = 0.3562853342360152
p-value = 0.7241634784025108
```

Sample Distribution of x — Sample Distribution of y

```
# Given a typical significance level (α) of 0.05, a p-value of 0.724.
# 0.724 is much greater than 0.05. This means:
# 1. There is weak evidence against the null hypothesis.
# 2. We fail to reject the null hypothesis.
# 3. There is not a statistically significant difference between the means of the two samples.
```

Leeds Doctoral College - University of Leeds
Quantitative Data Analysis
ANOVA in Python https://colab.research.google.com/drive/1-Q672tb7HZAU_u7HoVtsZ4plsrDS8QU-
By Heider Jeffer

In [1]:

```python
# Leeds Doctoral College - University of Leeds
# Quantitative Data Analysis with Python
# ANOVA
# in Python
# By Heider Jeffer
# June 20, 2024


import pandas as pd
from scipy.stats import f_oneway

# Sample data creation (if not reading from a file)
data = {
    'metric': [10, 12, 15, 14, 13, 16, 20, 22, 21, 19, 18, 24, 30, 32, 29, 31],  # Sample metrics
    'period': ['before', 'before', 'before', 'before', 'before', 'before', 'before', 'before',
               'after', 'after', 'after', 'after', 'after', 'after', 'after', 'after']  # 'before' or 'after'
}

# Convert to DataFrame
df = pd.DataFrame(data)

# Separate the data into two groups
before = df[df['period'] == 'before']['metric']
after = df[df['period'] == 'after']['metric']

# Perform ANOVA
f_statistic, p_value = f_oneway(before, after)

# Output the results
print(f"F-statistic: {f_statistic}")
print(f"P-value: {p_value}")

# Interpretation of the results
alpha = 0.05
if p_value < alpha:
    print("There is a significant difference between the performance metrics before and after digital transformation.")
else:
    print("There is no significant difference between the performance metrics before and after digital transformation.")
```

```
F-statistic: 17.329896907216494
P-value: 0.000957171784251362
There is a significant difference between the performance metrics before and after digital transformation.
```

```python
# Plot Welch's t-test by Heider Jeffer
import pandas as pd
from scipy.stats import f_oneway
import matplotlib.pyplot as plt

# Sample data creation (if not reading from a file)
data = {
    'metric': [10, 12, 15, 14, 13, 16, 20, 22, 21, 19, 18, 24, 30, 32, 29, 31],  # Sample metrics
    'period': ['before', 'before', 'before', 'before', 'before', 'before', 'before', 'before',
               'after', 'after', 'after', 'after', 'after', 'after', 'after', 'after']  # 'before' or 'after'
}

# Convert to DataFrame
df = pd.DataFrame(data)

# Separate the data into two groups
before = df[df['period'] == 'before']['metric']
after = df[df['period'] == 'after']['metric']

# Perform ANOVA
f_statistic, p_value = f_oneway(before, after)

# Output the results
print(f"F-statistic: {f_statistic}")
print(f"P-value: {p_value}")

# Interpretation of the results
alpha = 0.05
if p_value < alpha:
    print("There is a significant difference between the performance metrics before and after digital transformation.")
else:
    print("There is no significant difference between the performance metrics before and after digital transformation.")

# Plotting the results
plt.figure(figsize=(10, 6))

# Create box plots
plt.boxplot([before, after], tick_labels=['Before', 'After'])

# Add titles and labels
plt.title('Performance Metrics Before and After Digital Transformation')
plt.ylabel('Performance Metric')

# Show plot
plt.show()
```

```
F-statistic: 17.329896907216494
P-value: 0.000957171784251362
There is a significant difference between the performance metrics before and after digital transformation.
```

Performance Metrics Before and After Digital Transformation