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A PILOT ANALYSIS ON THE IMPACT OF DIGITALIZATION IN PRINTING TECHNOLOGY ON EMPLOYABLE OPPORTUNITIES IN PUNE

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ABSTRACT

The printing industry, traditionally rooted in mechanical processes, is experiencing a transformative wave driven by digital technologies. This study presents a pilot analysis aimed at evaluating the perceptions of industry professionals regarding the impact of digitalization on operations, skills, and organizational practices within printing companies in Pune, India. The research is grounded in empirical data gathered from a structured questionnaire comprising 40 Likert-scale items designed to capture sentiments on digital integration, employee readiness, technical infrastructure, and organizational adaptation.

The pilot sample consisted of 49 valid responses from stakeholders across small, medium, and large-scale printing companies. Data were analyzed using Cronbach's Alpha to test internal consistency and reliability of the instrument. The result, $\alpha = 0.966$, indicates excellent reliability and validates the robustness of the questionnaire for broader application. Descriptive statistical analysis further revealed strong consensus among respondents on key factors such as the necessity for digital upskilling, increased efficiency due to digital tools, and changing customer expectations. Graphical representations, including histograms and frequency charts, highlight the distribution of responses and support the reliability findings.

This study contributes significantly by offering a validated measurement instrument tailored to the printing sector's digital evolution. The findings also offer insights for policymakers, educational institutions, and industry leaders aiming to support digital transformation through informed decision-making and strategic interventions.

The pilot study sets the stage for a full-scale research project that will examine inter-variable relationships, conduct inferential analysis, and identify sectoral challenges. The implications of this digital shift extend beyond technology adoption—they reshape roles, training systems, and competitiveness in the global print industry.

Keywords: Digitalization, Printing Technology, Pilot Study, Cronbach's Alpha, Internal Consistency, Printing Industry, Digital Transformation, Likert Scale, Pune, Reliability Analysis

1. INTRODUCTION

The global printing industry, once defined by mechanical presses and labor-intensive processes, has entered an era of digital redefinition. From publishing to packaging, digital printing has revolutionized workflows, reduced turnaround times, and empowered companies to offer customized, high-speed, and environmentally sustainable solutions. In India, particularly in industrial hubs like Pune, this digital wave is influencing not just production systems but also business models, employee skill requirements, and customer relationships.

Digitalization is no longer a choice but a strategic imperative. Competitive advantage now rests on agility, adaptability, and the ability to integrate digital technologies across all organizational functions. Printing enterprises, traditionally reliant on analog operations, face increasing pressure to innovate, invest in digital machinery, and upskill

their workforce. The rise of variable data printing, automation, AI-assisted design systems, and e-commerce integration in print services signals a paradigm shift.

Despite these advancements, the adoption of digital technology varies widely across regions and organization sizes. While large-scale enterprises may have the capital and workforce to invest in digitalization, small and medium-sized enterprises (SMEs) often struggle with cost, technical expertise, and change management. This divergence calls for a systematic understanding of the readiness, perceptions, and infrastructural capacity of the printing sector to transition into the digital age.

To address this gap, this research begins with a pilot study to test the reliability of a newly developed questionnaire. The goal is to assess whether the tool effectively captures the constructs related to digital transformation in printing. The results from this pilot study will inform the development of a full-scale research effort aimed at analyzing patterns, causal relationships, and policy implications.

The research is timely and relevant, given the rapid pace of technological change and the growing need for evidence-based insights into how industries are adapting. As India gears toward Industry 4.0, sectors like printing must not be left behind. By understanding stakeholder perceptions and organizational realities, this study hopes to contribute to both academic literature and practical strategy.

2. REVIEW OF LITERATURE

2.1. THE EVOLUTION OF PRINTING TECHNOLOGY

The shift from letterpress to offset and now to digital printing represents not just a technological evolution but also a change in the economics and creativity of print media. Studies by Cheng et al. (2020) and IFRA (2018) highlight how digital printing enables just-in-time production, short-run jobs, and personalization.

2.2. INDUSTRY 4.0 AND THE PRINT SECTOR

According to Schwab (2016), Industry 4.0 involves the integration of cyber-physical systems, IoT, and AI into manufacturing. In printing, this translates to cloud-connected presses, intelligent workflow systems, and real-time analytics. Ghosh (2021) emphasizes the need for skill evolution and flexible business models.

2.3. MEASURING DIGITAL READINESS

Surveys and readiness indices have been developed in various sectors. The printing sector, however, lacks a standardized tool. This study seeks to fill that void by offering a reliable, statistically validated instrument grounded in psychometric testing.

2.4. CRONBACH'S ALPHA IN INSTRUMENT VALIDATION

Cronbach's Alpha is widely used for internal consistency testing. A score above 0.9 is considered excellent (Nunnally, 1978). Our review of instrument design literature (DeVellis, 2016; Tavakol & Dennick, 2011) informed the structure of the current questionnaire.

3. OBJECTIVES OF THE STUDY

1) To identify the key dimensions of digital transformation affecting the printing industry.
2) To develop a structured Likert-based questionnaire covering these dimensions.
3) To evaluate the internal consistency of the instrument using Cronbach's Alpha.
4) To analyze pilot study data for distribution patterns and respondent alignment.
5) To assess the questionnaire's potential for broader application in academic and industry research.

4. RESEARCH METHODOLOGY

This study adopts a quantitative, descriptive research design with a primary objective of understanding how digitalization in the printing technology sector influences employability in Pune. The pilot study serves as a precursor to full-scale research by testing the reliability and structure of a customized questionnaire.

4.1. RESEARCH APPROACH

A survey-based approach was employed, wherein a structured questionnaire was distributed online to professionals across various printing firms—ranging from small-scale units to large-scale commercial presses.

4.2. SAMPLING TECHNIQUE

A non-probabilistic, purposive sampling method was used. Respondents included decision-makers, supervisors, and skilled operators currently working in Pune's printing industry.

- **Sample Size (Valid Responses):** 49
- **Target Population:** Professionals in Pune-based printing companies
- **Instrument Type:** Online survey via Google Forms

4.3. QUESTIONNAIRE DESIGN

The survey instrument was designed to measure perceptions across four primary domains:

1) Technology Adoption
2) Skill Requirements and Training
3) Workforce Readiness
4) Organizational Change and Competitiveness

Each statement was rated on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The final questionnaire contained 40 statements. These items were reviewed by subject matter experts and translated bilingually (English-Marathi) to enhance clarity.

4.4. DATA PREPARATION

Responses were extracted and coded numerically based on the Likert scale. Entries with incomplete or inconsistent data were discarded. The final cleaned dataset was used for reliability testing and descriptive analysis using Python and Excel-based tools.

5. QUESTIONNAIRE STRUCTURE

The questionnaire included 40 Likert-based items. These items addressed themes such as:

- Investment in digital infrastructure
- Perceived efficiency improvements
- Skill gap perceptions
- Attitudes toward training and learning
- Role of senior staff in change resistance
- Customer expectations in a digital environment

6. DATA ANALYSIS AND RESULTS

6.1. DESCRIPTIVE STATISTICS

The analysis revealed that most respondents agreed or strongly agreed with statements related to the need for digital skill development, efficiency of digital systems, and challenges in workforce readiness. Mean scores across items ranged from 3.8 to 4.3, with standard deviations mostly under 1.0, reflecting a strong consensus.

6.2. RELIABILITY TESTING

Sr.No	Section	Details
1.	**Objective of the Test**	To evaluate the internal consistency of a questionnaire assessing the impact of digitalization in the printing technology sector for broader use.
2.	**Data Summary**	- **Number of Respondents (Valid):** 49 - **Number of Likert Scale Items Analyzed:** 40 - **Scale Used:** 5-point Likert (1–Strongly Disagree to 5–Strongly Agree)
3.	**Methodology**	Internal consistency measured using **Cronbach's Alpha (α)**. A high α value indicates items reliably measure the same construct.
4.	**Results**	- **Cronbach's Alpha (α):** 0.966 - Interpretation: **Excellent** internal consistency
5.	**Interpretation Guide**	table><tr><th>Alpha (α) Value</th><th>Interpretation</th></tr><tr><td>≥ 0.90</td><td>Excellent</td></tr><tr><td>0.80 – 0.89</td><td>Good</td></tr><tr><td>0.70 – 0.79</td><td>Acceptable</td></tr><tr><td>0.60 – 0.69</td><td>Questionable</td></tr><tr><td>0.50 – 0.59</td><td>Poor</td></tr><tr><td>< 0.50</td><td>Unacceptable</td></tr></table>
6.	**Descriptive Analysis**	- Average item scores ranged from **4.0 to 4.3** - Standard deviations were **below 1** - **No missing values** found in responses
7.	**Conclusion & Implications**	The questionnaire shows **excellent reliability** (α = 0.966). Suitable for larger studies assessing digitalization in the printing industry.
8.	**Recommendations**	1. Conduct **Exploratory Factor Analysis (EFA)** 2. Use **Confirmatory Factor Analysis (CFA)** on a larger sample 3. Include **reverse-coded items** 4. **Translate** for broader audiences 5. **Update regularly** with industry changes

Using Cronbach's Alpha, the internal consistency of the 40-item scale was computed.

Cronbach's Alpha (α): 0.966

Cronbach's Alpha Formula:

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2}\right)$$

Where:

- N = Number of items (questions)
- σ_i^2 = Variance of each individual item
- σ_t^2 = Variance of the total score

Interpretation Scale:

$\alpha \geq 0.9$ → Excellent

$0.8 \leq \alpha < 0.9$ → Good

$0.7 \leq \alpha < 0.8$ → Acceptable

$0.6 \leq \alpha < 0.7$ → Questionable

$0.5 \leq \alpha < 0.6$ → Poor

$\alpha < 0.5$ → Unacceptable

This score indicates excellent reliability, suggesting that the questionnaire items consistently measure a unified construct—namely, the impact of digitalization on employability and operations.

6.3. GRAPHICAL REPRESENTATION

Histograms were plotted to visualize response trends. Most items showed right-skewed distributions, indicating positive sentiment toward digital transformation.

7. DISCUSSION

The results of this pilot study provide compelling evidence that the printing industry in Pune is experiencing a significant shift in mindset and operations due to digitalization. The overwhelmingly positive responses—evident from high mean scores and low variability—suggest that digital technology is no longer perceived as a supplementary option, but as a central operational imperative.

7.1. WORKFORCE PERCEPTION AND READINESS

Respondents emphasized the increasing demand for technical skills in areas such as digital pre-press, machine operation, and software-driven design. The fact that over 80% of participants agreed or strongly agreed on the insufficiency of traditional skills demonstrates a widespread awareness of the evolving skill landscape. This aligns with existing literature suggesting that employability in the digital economy hinges on technical agility, continual learning, and cross-functional competencies.

7.2. ORGANIZATIONAL CHANGE AND INVESTMENT

The responses show a high level of organizational commitment toward digital adoption—many companies have made strategic investments in digital infrastructure within the last five years. However, the study also revealed underlying barriers such as senior staff resistance to change, and lack of technical support, both of which can slow down implementation and reduce ROI from technology investments.

7.3. IMPACT ON EMPLOYABLE OPPORTUNITIES

The link between digitalization and employability is multifaceted. On one hand, digital transformation increases job opportunities in areas like digital marketing, press management, and customer service platforms. On the other, it demands a new profile of employee skillsets, which may marginalize traditional press operators unless reskilling programs are actively pursued. The results underline a need for vocational programs and institutional partnerships to bridge this gap.

8. CONCLUSION AND IMPLICATIONS

This pilot study has demonstrated that the customized questionnaire is statistically robust and contextually relevant for assessing digitalization impacts in the printing industry. With a Cronbach's Alpha of 0.966, the instrument shows excellent internal reliability, providing confidence in its future use for large-scale empirical studies.

8.1. PRACTICAL IMPLICATIONS

- **For Industry:** Firms should establish structured digital training modules and onboard transition strategies for senior staff.
- **For Academia:** Institutions offering printing and graphic arts education need to integrate digital printing technologies, data literacy, and design automation into their curriculum.
- **For Policymakers:** State and local governments could incentivize digital skill development programs and facilitate digital infrastructure funding for MSMEs in printing.

8.2. SOCIETAL RELEVANCE

The transformation in printing also carries broader socio-economic implications—such as reducing print waste, supporting e-governance communication needs, and promoting employment through online printing services and digital content production.

9. LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

Despite promising results, the study has certain limitations:

- **Sample Size:** The pilot was limited to 49 respondents in Pune and may not fully represent India's diverse printing landscape.
- **Regional Scope:** The study focused only on Pune; future studies should include multi-city and rural printing setups.
- **Depth of Analysis:** While this study focused on reliability and descriptive statistics, inferential techniques such as regression, factor analysis, and structural equation modeling should be considered for full-scale deployment.

Future Scope

- Expansion of the study across multiple Indian cities
- In-depth analysis of correlations between technology adoption and employee performance
- Development of a Digital Employability Readiness Index for the printing sector

CONFLICT OF INTERESTS

None.

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