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# DIGITAL AGILITY, COMPETITIVE ADVANTAGE, AND CLOUD COMPUTING ADOPTION: UNLEASHING DIGITAL TRANSFORMATION IN LIBRARIES OF PAKISTAN

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## ABSTRACT

***Purpose-*** *This study explored the interrelationship between the DA, CA, CC adoption and DT in the context of librarians in Pakistan.*

***Methods-*** *The survey method was used. The questionnaire gathered data from librarians. The sample was randomly recruited from KP. Collected data was scrutinized and analysis were performed for five hypotheses testing by SPSS and AMOS software.*

***Results-*** *All hypotheses are approved except the link between the CA and CC adoption. The results affirmed that competitive advantage and agility are essential for the adoption of CC and ensure digital transformation.*

***Originality-*** *this is the 1st attempt in librarianship that explore the link of such constructs among the librarians and extend the scope of the study. The results are not only beneficial in the Pakistani context but also important for global digital transformation.*

***Keywords-*** *Technology implementation, innovations, knowledge management, information management, Pakistan.*

## INTRODUCTION

Digital transformation (DT) has now become of primary concern for organizational viability in the new era of unprecedented competition and technological advancements. In libraries, therefore, digital transformation means much more than just the digitization of collections; it entails the systemic integration of digital platforms to provide easier access, delivery, and user interface with information resources (Nouvellet et al., 2019; Anuradha, 2020). Whereas in a normal sense, digital transformation might just be seen as an upgrade in technology, it is a shift away from traditional human services to automated systems modes of librarianship (Shoham & Klain-Gabbay, 2019). Fitzgerald et al. (2014) describe it as introducing advanced technology, including mobile communications, analytics, cloud computing, and interconnected systems of digital technology, to improve services, smoothen operations, and innovate the service delivery models. Less-referenced in their texts is the transformation realized through the repositioning of libraries as customer-centric institutions, with digital tools used to enhance usability, improve efficiencies, and maintain relevance. Cloud-based solutions, in particular, are being deployed to back this change and to strategically position libraries within the digital ecosystem, especially in developing countries.

Cloud computing (CC) has become a fundamental enabling technology for DT for ever-increasing penetration of web technologies, worldwide internet connectivity, and on-demand digital services. This is being put to use in educational libraries, especially in industrialized countries, for the distribution of information, digital space, assessment, and scalable collection development (Sudhier & Seena, 2018). Cloud computing has a trio of models for service supply: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). It offers distant accessibility to resources using networks hosted off-site by third-party data centers, thereby giving the customer flexibility to choose their services according to their business environment (Yuvaraj, 2015). According to Microsoft (2022), CC covers services through computers comprising mainframe systems, archives, storage, and software by utilizing the Internet. Enabling rapid, location-independent access, cost efficiency, and infrastructure optimization. Similarly, Mell and Grance (2011) stated that it grants global connections. By adopting cloud-based systems, academic libraries can enhance service delivery, reduce operational burdens, and tailor infrastructure to institutional requirements, positioning themselves for sustainable digital advancement.

CC use networked systems, enabling scalable access to digital infrastructure without the need for extensive local investment (Rahoo, 2020). Functioning as a virtual hub for information and knowledge exchange, it holds particular promise for resource-constrained environments, offering a cost-effective alternative to traditional library systems (Yuvaraj, 2016). Cloud-based functions provide access to library services by using remote digital devices, including mobile platforms, to attract users in developing countries like Pakistan; by providing library services, users can benefit from its services through this means (Aiyebelehin et al., 2020). The users are allowed to browse through available digital collections and cloud-connected catalogues and retrieve content using their mobile phones or tablets, including functionalities that support barcodes. For libraries with huge amounts of digital content, it enables them to ease storage in the local infrastructure and most importantly, secure preservation, backup and dissemination of electronic resources (Kandil et al., 2018). It involves putting up such models which require librarians to develop very strong competencies in technology and be digitally agile enough to continue operating effectively in this transformed service landscape. In the end, the nullification of the antecedent context of success for the cloud in library environments will therefore lie in the degree of institutional readiness and adaptability of professionals to a substitutive digital ecosystem.

Having digital agility (DA) is much more than an IT concern; it denotes the cultural attitude of an organization toward being in a constant state of innovation and readiness for change. Leadership in corporations manifests this mentality as one of demanding that an advanced infrastructure is in place, the appropriate digital tools acquired for solutions, and the training of the labour force to sustain high adaptability to change. More than just adaptation toward operations, digital agility means companies can foresee and proactively counter any technological disruptions and changing user wants. Digital agility is their fast and resilient way of tackling complexity and securing competitive advantage (CA). In their study, Salmela et al. (2022) write that digital agility is a comprehensive concept involving strategic foresight, sound technological ecosystems, and the readiness of human capital to help organizations survive in fast digital environments.

Digital transformation and cloud computing, as parts of an integrated solution, enable an organization to improve its capacity to attain and retain competitive advantage by optimally high performance compared with others. Technology acquisition, service standards, skilled human resources, and contemporary collections contribute to differentiated institutional profiles. According to Sachitra (2017), competitive advantage is the capability to provide comparatively better services and products than other players in the market. For libraries, competitive advantage translates into strategic positioning in terms of embracing technology innovations and excellent services.

The linkages among the DA, DT, CA and CC adoption have been established in previous studies in the business and management sciences, such that they are fundamentally unexplored in an area like Pakistani librarianship. The factors affecting cloud computing adoption and

librarians' digital transformation implementation remain rather nebulous. Thus, this research is knowing the interrelationships among the constructs concerning their direct and indirect effects. The study aims to explore how digital agility and competitive advantage affect cloud computing adoption, how cloud computing adoption affects digital transformation, and how cloud computing adoption acts as a mediator between DA, CA, and DT among librarians.

## 2. Research Model and Hypotheses

As revealed in Figure 1, The proposed model integrates four key constructs: digital agility, competitive advantage, cloud computing adoption, and digital transformation. It examines their interrelationships through a two-tiered approach. First, it assesses the direct associations among the constructs. Second, it explores the impact of CC on the link between DA and CA with the DT.

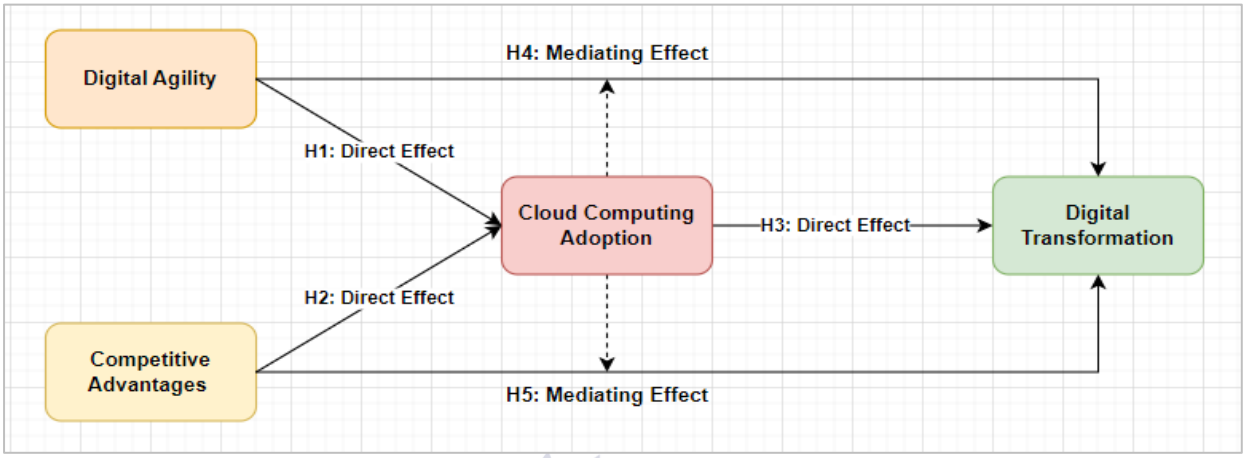



**Figure 1: Model of the study**

### 2.1 Digital Transformation

Digital transformation has facilitated better service delivery, improved government administration, and augmented accountability (Maremi et al., 2022). Even in Pakistan, it has introduced e-government services in the fields of health, education, travel, defence, digital census, security, banking, enterprise solutions and others. Thus, it has become mandatory for the progress of any nation. Because of its dominant role, it has impacted libraries, institutional repositories, publishing, research databases management and the format of the information products. To cope with these it has given birth to several issues such as limited financial resources, scarcity of experts, and absence of robust technological infrastructure (Klein & Todesco, 2021). Regardless of such challenges, it is coercing librarians to mould the foundational structure of libraries that is from the transition from traditional to the contemporary role where digital transformation has granted access to the utilization of technical gadgets demanding tech-savvy workforce. This has created a competitive environment for libraries (Singh & Asif, 2019). Currently, organizational authorities are dictating librarians to new technologies to support library users in their information needs. Libraries can only accept digital transformation if old professional methods are discarded (Yuvaraj, 2016). Although this transition is difficult this challenge can be discounted (Khattak, 2022).

### 2.2 Digital Agility and Cloud Computing Adoption

Empirical evidence suggests a strong linkage between digital agility and cloud computing adoption. Deng et al. (2021) reported the influence of DA on CC that increased cloud adoption reinforces organizational agility. Similarly, Zaini et al. (2022) affirm the effect of CC on both digital and organizational agility. Hence one proposes the following hypothesis:

$H_1$: *DA significantly impacts CC adoption.*

### 2.3 Competitive Advantage and Cloud Computing Adoption

Extant literature affirms that cloud computing adoption contributes significantly to competitive advantage. Avendaño (2018) and Asha (2022) emphasize its role in enhancing organizational competitiveness, while Gangwar (2017) and Chang et al. (2019) highlighted its impact on

operational efficiency, cost reduction, and workforce productivity. There is a strong link between CC adoption and performance outcomes (Tella et al., 2020). Moreover, Luo et al. (2018) identify CC adoption as a strong indicator of sustained competitive advantage. In dynamic and competitive environments, adopting emerging technologies is linked to improved efficiency and strategic positioning (Miss, 2021). In light of this evidence, a hypothesis is proposed:

*$H_2$: CA significantly impact CC adoption*

### 2.4 Cloud Computing Adoption and Digital Transformation

CC adoption provides access to information through digital systems (Dutt, 2015). Data centers deliver requested resources by broadband, serving customers globally (Yuvaraj, 2013). Major cloud platforms like Microsoft offer tools for application management, development, and service delivery (Kutty, 2019), while services such as Amazon Web Services, Google Docs, and Google Drive exemplify the diverse offerings of cloud computing. In libraries, cloud computing supports the preservation of electronic and digitized resources for future generations (Kandil et al., 2018). Furthermore, CC adoption is essential for digital transformation, enhancing productivity, and operational efficiency (Bucci et al., 2019; Junge, 2019). Cloud adoption can revolutionize traditional processes, fostering growth and improved market positioning. As such, CC adoption is positively associated with digital transformation (Al-Rwaidan et al., 2023). One proposes the hypothesis:

*$H_3$: Cloud computing adoption significantly impacts digital transformation.*

### 2.5 Digital Agility, Cloud Computing and Digital Transformation

The significance of embracing newer technology has been proven by many researchers to be a mediating variable affecting digital resilience and competitive advantage (Zeng et al., 2022). Companies that adopt advanced technology and enhance their capacity have more control over digital solutions, thus improving performance (Khin & Ho, 2018). The adoption of innovative ideas has been proven to mediate employees' agility (Wei et al., 2020). Hence, one proposes the following hypothesis:

*$H_4$: CC adoption mediates the link of DA with DT*

### 2.6 Competitive Advantage, Cloud Computing and Digital Transformation

Digital proficiency builds ways for digital innovations, thus giving the preposition that organizations can transform digitally to perform better (Wei et al., 2020) and hence develop a culture that is digitally oriented and can be adaptable to technology and capable of sustaining competitive advantage (Khin & Ho, 2018). Likewise, Khattak (2022) established that the adoption of digital platforms influences novel culture and performance. Besides, digital transformation ensures the attainment of technological capabilities, customer engagement, system automation, organizational capabilities, enhancement of agility, and collaborations (Kruszyńska-Fischbach et al., 2022). The preceding discussion led to the formulation of the below hypothesis:

$H_5$: *CC adoption mediates the link of CA with DT*

## 3. Methodology

The nature of research is quantitative while the method used is survey. The total population comprised 162 university librarians. A list of accredited universities in KP was compiled from the Higher Education Commission portal, including 11 private and 33 public universities. Contact information for librarians was obtained from university websites, allowing the construction of a comprehensive contact list. The sample size was 115 identified statistically. A pre-tested questionnaire, based on a validated instrument, was used to collect data. The instrument employed a 5-point Likert scale. Reliability values, adhering to Sekaran and Bougie's (2016) recommendation of 0.60 as the minimum threshold, were found to be satisfactory, as detailed in Table 1. A total of 141 questionnaires were distributed via postal services and electronically, yielding 133 responses. After reviewing for completeness and accuracy, 18 responses were discarded, leaving 115 valid questionnaires for analysis. The response rate was 81.56%. Data analysis was performed using SPSS and AMOS software.

Table 1: Cronbach Alphah Values Reliability

| Constructs | Questions | Cronbach Alpha value |
|---|---|---|
| Digital Transformation | 11 | 0.748 |
| Cloud Computing adoption | 9 | 0.802 |
| Digital Agility | 6 | 0.693 |
| Competitive Advantages | 10 | 0.762 |
| Composite Reliability | 36 | 0.751 |

## 4. Results and Discussion

### 4.1 Demographics

Out of the survey respondents, 47% (n=89) are males and 22.6% (n=26) are females, marking an even higher representation of males than females. According to educational qualification, 47% (n=54) had a master's degree, 49.6% (n=57) were doing an MPhil, and 3.5% (n=10) had a Ph.D. These figures portray that the majority of respondents were master's degree holders. Based on age, a majority (n=60) represented respondents between 25 and 35 years of age, trailed by 30.4% (n=35) in ages 36-45 years, 15.7% (n=18) between 46-55 years, and 1.7% (n=2) comprising those over 55 years. The largest section of respondents was those aged 25-35. In addition, 61.7% (n=71) of all respondents were part of public universities, whereas 38.3% (n=40) comprised students from private universities.

### 4.2 Pearson Correlation Analysis

About Table 2, it was also found that correlation analysis established significant relationships among the variables of digital transformation, cloud computing adoption, digital agility, and competitive advantage. It was found that DT appeared to have very considerable links to CCA (0.365), DA (0.385), and CA (0.324). This was the same by CCA, demonstrating a moderated link of DA (0.40), but it showed a weak correlation of CA (r=0.133, p=0.158). DA moderated the link of DT (0.385) and CA (0.379). Finally, CA had moderate positive correlations with both DT (0.324) and DA (0.379), but the correlation for CCA was weaker (r=0.133, p=0.158).

Table 2: Pearson Correlations Results

| | | DT | CCA | DA | CA |
|---|---|---|---|---|---|
| DT | Pearson Correlation | 1 | | | |
| | Sig. (2-tailed) | | | | |
| | N | 115 | | | |
| CCA | Pearson Correlation | .365** | 1 | | |
| | Sig. (2-tailed) | <.001 | | | |
| | N | 115 | 115 | | |
| DA | Pearson Correlation | .385** | .401** | 1 | |
| | Sig. (2-tailed) | <.001 | <.001 | | |
| | N | 115 | 115 | 115 | |
| CA | Pearson Correlation | .324** | .133 | .379** | 1 |
| | Sig. (2-tailed) | <.001 | .158 | <.001 | |
| | N | 115 | 115 | 115 | 115 |

**. Correlation is significant at the 0.01 level (2-tailed).

### 4.3 Regression Analysis

This test was applied to know the link of outcome with predictors. As reported in Table 3, the model was significant ($p < .001$), meaning the predictors jointly account for an untold percentage of the variance in DT. CCA is said to significantly and positively influence DT ($\beta = .257$, $p = .005$), meaning that a person who scores high on the dimension of CCA is likely to score high on DT. Similarly, DA was positively related

to digital transformation (β = .200, p = .041), meaning that higher levels of DA are likely to indicate high levels of DT. CA also had a positive correlation with digital transformation (β = .214, p = .018), implying a high score on CA is related to an increasingly higher score on DT. The 95% confidence intervals on those coefficients give a range within which true values for population parameters are expected to fall. These findings indicate that CCA, DA, and CA predict DT and explain the relationship of those variables among one another.

**Table 3: Linear Regression coefficients**

| Model | | Coefficients• | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Unstandardized Coefficients | | Standardized Coefficients | | | 95.0% Confidence Interval for B | |
| | | B | Std. Error | Beta | t | Sig | Lower Bound | Upper Bound |
| 1 | (Constant) | 21.382 | 2.880 | | 7.424 | <.001 | 15.675 | 27.089 |
| | Cc | 0.166 | 0.059 | 0.257 | 2.840 | 0.005 | 0.050 | 0.282 |
| | DA | 0.185 | 0.089 | 0.200 | 2.072 | 0.041 | 0.008 | 0.361 |
| | CA | 0.120 | 0.050 | 0.214 | 2.398 | .DIS | 0.021 | 0.219 |
| a. Dependent Variable: OT | | | | | | | | |

### 4.4 Analysis of Variance

In predicting DT with CA, CCA, and DA as predictors, ANOVA has shown the overall significance of the model (p < .001). Since the regression sum of squares (SSR = 249.455) is higher than the residual sum of squares (SSE = 788.075), affirming variation in DT. The F and P values provide further evidence of the model's overall significance. These results further substantiate the claim posed in Table 4 that CA, CCA, and DA significantly account for the explanation of variation in DT. Results are explored in Figures 2 and 3.

**Table 4: The ANOVA results**

| ANOVA[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | Df | Mean Squares | F | Sig. |
| 1 | Regression | 249.455 | 3 | 83.152 | 11.712 | <.001[b] |
| | Residual | 788.075 | 111 | 7.100 | | |
| | Total | 1037.530 | 114 | | | |
| a. Dependent Variable: DT<br>b. Predictors: (Constant), CA, CC, DA | | | | | | |

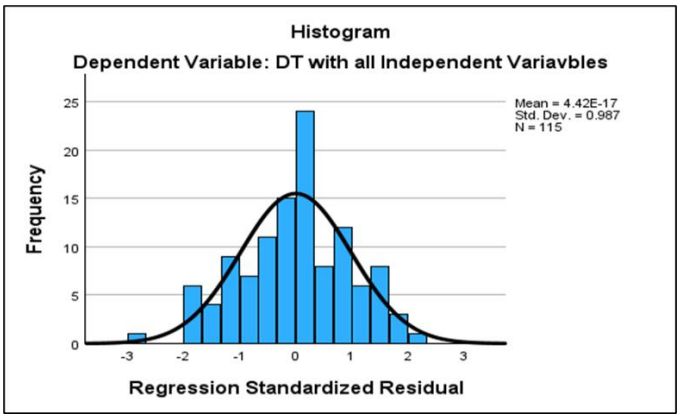



**Figure 2: Histogram**

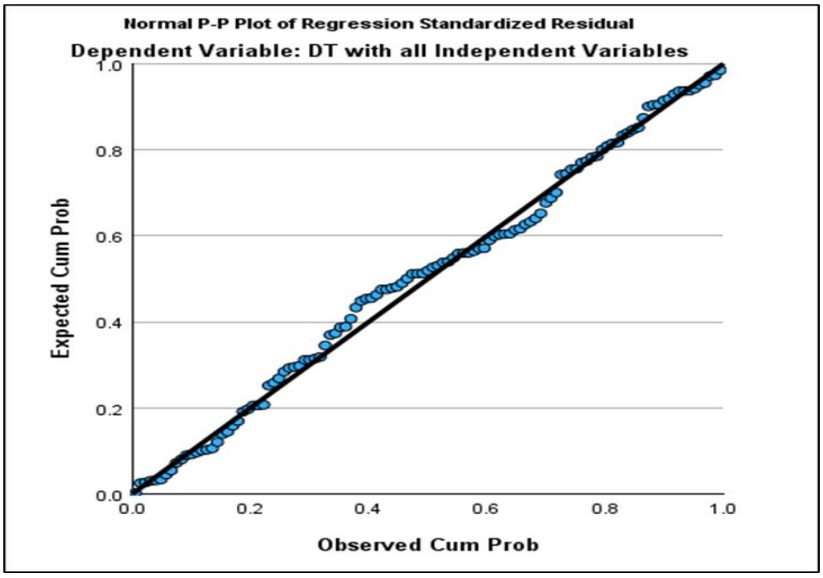



**Figure 3: Normal P-P Plot**

### 4.8 Confirmatory Factor Analysis

This study employed AMOS (version 28) to perform Confirmatory Factor Analysis (CFA), evaluating the model's validity and its ability to consistently measure the intended construct while distinguishing it from others. Figures 4 and 5 indicate the illustrated demonstration of both confirmatory factor analysis models initial and final incorporating the intermediation effects.

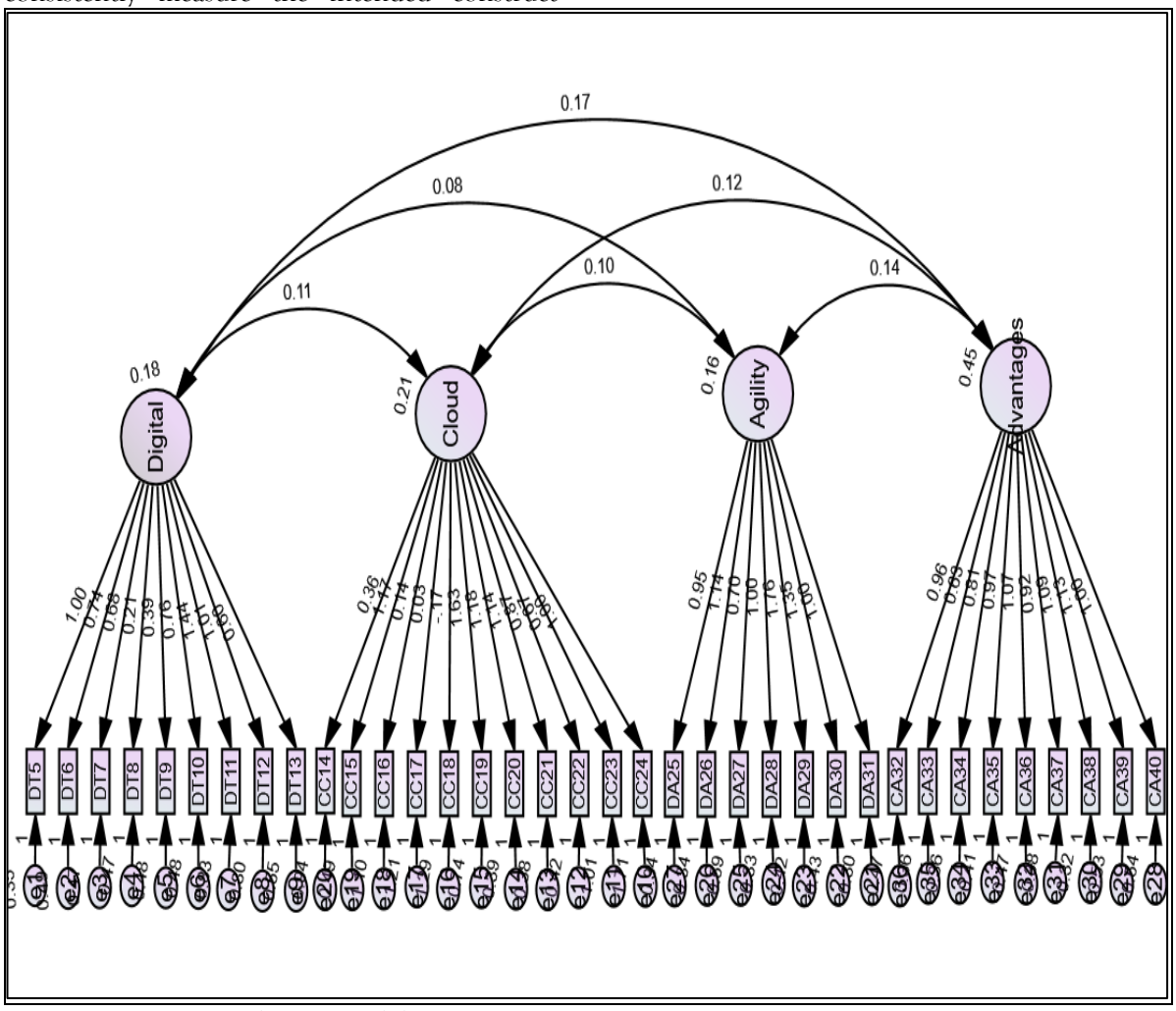
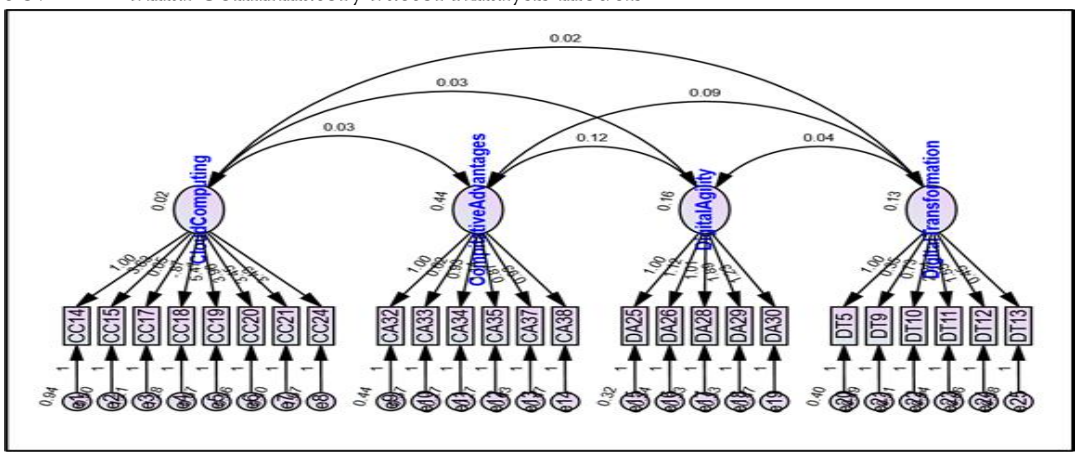
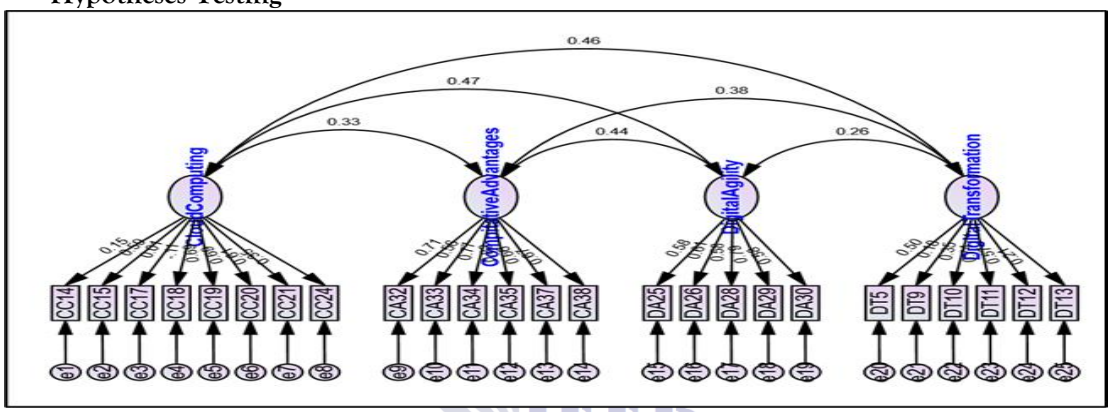



**Figure 4: Initial CFA model**

**Figure 5:** Final Confirmatory Factor Analysis models




## 4.9 Hypotheses Testing




The conducted study represents a conceptual model (CM) that encompasses five hypotheses to be empirically tested for their interrelationships. Structural equation modelling (SEM), a multivariate analysis as implemented on AMOS software, was carried out with causal modelling and standardized estimates via CFA to assess the relationships. CC adoption served as a mediator between DA CA and DT. The results for the structural model run are shown diagrammatically in Figures 6 and 7.

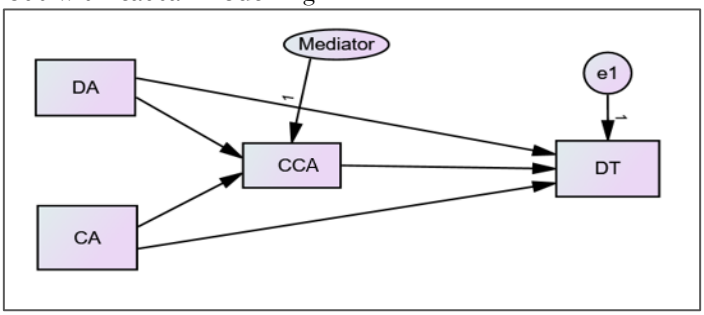



**Figure 6:** Proposed Structural model for Hypothesis testing

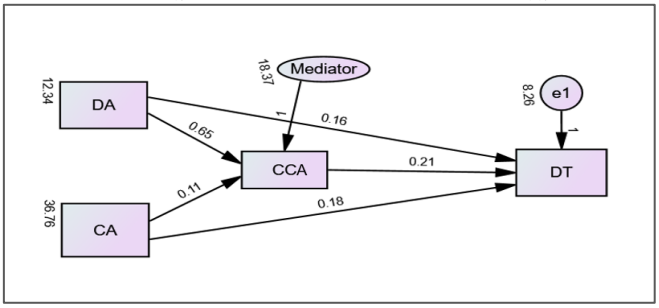



**Figure 7:** Final Structural model

Findings revealed a strong model fit, with a root mean squire residual (RMR) of 0.031, the goodness of fit index (GFI) of 1.091, and a comparative fit index (CFI) of 0.971. However, the RMSEA value of 1.261 exceeded the acceptable threshold of 0.08, indicating a need for further refinement in model fitness. Path analysis results showed that cloud computing significantly impacts digital transformation ($\beta$ = 0.651, $p < 0.05$), while competitive advantages also exert a significant influence over digital transformation ($\beta$ = 0.181, $p < 0.05$). Thus, hypotheses H1, H3, and H5 were supported, while H2 and H4 were rejected, as detailed in Table 5.

**Table 5: Hypotheses testing status**

| H. No | Paths | Estimate | S.E. | C.R. | P | Remarks |
|---|---|---|---|---|---|---|
| H1 | CCA <--- DA | .651 | .127 | 5.112 | *** | $H_1$ is supported |
| H2 | CCA <--- CA | .114 | .074 | 1.541 | .123 | $H_2$ not supported |
| H3 | DT <--- CCA | .215 | .063 | 3.417 | *** | $H_3$ is supported |
| H4 | DT <--- DA | .165 | .095 | 1.742 | .081 | $H_4$ not supported |
| H5 | DT <--- CA | .181 | .050 | 3.611 | *** | $H_5$ is supported |

**Model Fitness**: *Chi-square/ degree of freedom=2.821, (X2/df=< 3)*
**RMSEA** *(root mean square error of approximation) =1.261*
**RMR** *(root mean square residual) =.031*
**GFI** *(goodness of fit index) =1.091*
**CFI** *(comparative fit index) =.971*
**DA**=digital-agility, **CA**=competitive-advantages, **CCA**=cloud-computing adoption, **DT**=digital-transformation.

### 4.10 Mediation Effect

Results shown in Table 6 indicate that cloud computing presents itself as an important mediator that exerts a positive influence on the other three constructs. Specifically, the indirect effect of DA to CC was $\beta$ = 12.337 ($p < 0.05$), indicating a mediated influence. There was also an indirect effect of CCA on CA ($\beta$ = 36.762, $p < 0.05$) and on DT ($\beta$ = 8.263, $p < 0.05$) and found significant.

**Table 6: Estimates of correlations**

| H. No | Path analysis | Indirect effect | Direct | P | Remarks |
|---|---|---|---|---|---|
| H6 | DA<---CCA | 12.337 | .651 | *** | Supported |
| H7 | CA<---CCA | 36.762 | .114 | *** | Supported |
| H8 | DT<---CCA | 8.263 | .215 | *** | Supported |

## 6. Discussions

**Hypothesis 1**: The relation between DA and CC was observed to the strong and positive implying that higher digital agility in organizations correlates with greater adoption of cloud computing. Owusu-Tucker and Stacey (2018) support this, showing that strategic agility is an indicator of CC adoption in particular. This was also evidenced by Deng et al. (2021), who found a strong relationship among IT induction, agility, and cloud adoption.

**Hypothesis 2**: The association between CA and CC adoption is insignificant. This suggests that competitive advantage does not directly influence CC adoption. While Luo et al. (2018) pointed out the tactical role of CC adoption for long-standing CA, the findings indicate that CCA is not primarily driven by competitive advantages, as discussed by Miss (2021).

**Hypothesis 3**: Cloud Computing Adoption (CCA) significantly impacts Digital

Transformation (DT). This confirms that higher cloud adoption correlates with greater digital transformation. Supporting studies, such as Bucci et al. (2019), and Junge (2019) affirm the link of cloud technologies in driving digital transformation in organizations.

**Hypothesis 4**: The mediating effect of CCA amongst DA and DT is significant, confirming that CCA mediates the association among DA and DT. Zeng et al. (2022) and Khattak (2022) provide evidence of the role of digital resilience and innovative cultures as mediators in similar contexts.

**Hypothesis 5**: The mediating relation of CCA between Competitive Advantage (CA) and DT is meaningful. This suggests that CCA facilitates the impact of CA on DT. These findings align with the work of Khattak (2022) and Kruszyńska-Fischbach et al. (2022), who discuss the substantial effect of technology on performance and innovation culture.

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