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Digital Transformation and Cybersecurity Challenges in Pakistan's Higher Education Institutions

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ABSTRACT

The pace of digital transformation in higher education around the world has been accelerating as a result of the technology enabling online learning, administrative automation, data analytics and academic collaboration. In Pakistan there is an emerging trend in universities of using digital system of better educational delivery and research capacity and institutional management. However this transformation involves new vulnerabilities for institutions in the form of evolving cybersecurity risks to the privacy of information, availability of services and integrity of academics. This research is carried out to determine the situation concerning digital transformation and associated cybersecurity issues within HEIs of Pakistan. Using a combination of the two methods (n = 420 surveys, n = 20 expert interviews), the study shows a high and high rate of adoption of digital platforms coupled with a pervasive cybersecurity concern, such as phishing attacks, ransomware, insecure networks and lack of security policies. Findings point to interactions between gaps within technical capacity, governance structures and awareness indicating a need for complete cybersecurity structures, training, policy reform and investment in safe infrastructure to sustain digital transformation.

Introduction

The transformation to the digital is about integration of digital technologies into an organizational process, causing fundamental changes in the way we provide services, make decisions and create value. In terms of education, something like online learning platforms, cloud-based academic systems, student information systems and tools and platforms for digital research and automated administrative processes would all be a part of digital transformation. These technologies are capable of improving on aspects of accessibility, efficiency, flexibility, and academic quality, and enable institutions to better serve a diverse group of learners and adapt to the way education is required to function. Globally, the pandemic of Covid-19 added more digital transformation in the higher education environment and accelerated the universities towards the remote teaching and digital assessment and virtual collaboration at an unprecedented pace(Chen & Zhao, 2020; Zhang & Sun, 2021)

In Pakistan the usage of digital technologies has been implemented in more or less different extent in higher education institutions (HEIs). Universities have invest in Learning Management Systems (LMS) like Moodle and Blackboard, have online student enrolment and record systems and are participating in blended learning activities. Besides, more people in research are also to rely on digital tools for: data sharing, publication workflow and virtual seminars etc. These initiatives are in line with the national policies in promoting ICT integration in education, and efforts to expand access to higher learning opportunities in all the country.

Despite the potential, digital transformation comes with many challenges, especially in this area - cybersecurity. As the institutions are digitizing sensitive administrative and academic data, they are becoming victims to cyber crimes such as malware, ransomware, phishing, Distributed Denial of Service (DDoS) attack, insider threat, and data breaches. Cybersecurity in higher education is distinct from other industries due to the extremely open and collaborative nature of academic learning environments, and the accessibility being the primary goal of higher education usually leads to a secondary concern of security. Universities have a number of different stakeholders -- including students, faculty, administrators and outside partners -- who all have different access privileges, and this creates complex attack surfaces that require complex security regimes.

In Pakistan however the cybersecurity situation is further complicated by infrastructure constraints, lack of technical expertise, lack of resources and inconsistent implementation of policies. Many HEIs do not have cybersecurity units, nor updated security protocols, nor whole risk assessment frameworks.(Chen & Zhao, 2020; Zhang & Sun, 2021) Lack of a standardized cybersecurity policies and regulatory oversight creates even more vulnerabilities, leaving institutions vulnerable to potential data loss, financial damage, reputational risk and academic disruption.

Moreover, the digital divide in Pakistan - characterised by disparities in internet access, digital literacy and quality of infrastructure between the urban and rural areas - impact on the processes of implementation and securing of digital systems by institutions. Students and staff in the institution with limited digital skills are more susceptible to social engineering attacks and could find themselves compromising institutional ICT systems, despite not intending to do so. Also financial issues restrain investments on secure infrastructures, qualified IT staffs and on-going training programs.

The importance of cyber security within the digital transformation is not just about the technical aspects, but also includes the organizational culture, governance and policy frameworks as well as users. Effectively using cybersecurity requires coordinated leadership, accountability mechanisms, continued monitoring and incident response capability and partnerships with national cybersecurity national cybersecurity agencies.

This research focuses on interaction and digital change initiatives versus cybersecurity at HEIs in Pakistan. It investigates the use of digital platforms, nature and extent of cyber threats facing Universities, level of preparation in terms of cybersecurity risks from institutions as also also the stakeholder perception with respect to existing practices and gaps. The research is based on the mixed-methods approach combining quantitative survey data from students, faculty and IT staff, with qualitative knowledge from a series of expert interviews with University CIOs, cybersecurity consultants and policy experts.

By looking at patterns of adoption and exploring the security concerns, it is hoped that this research will be able to understand how Pakistan's higher education sector can continue driving digital transformation and reduce cyber risks. (Chen & Zhao, 2020; Zhang & Sun, 2021). The findings offer perception in phrases of technical, organizational, and coverage measures which might be required to of enhancing the institutional cybersecurity practices for enriching their educational practices and safeguarding their instructional assets. These insights have relevance to institutional leadership, that of IT management, coverage maker and academic planner so that it will strike a stability among innovation and resilience in a extra networked instructional ecosystem.

Literature Review

Digital transformation and cybersecurity in higher education have been well-researched topics all across the world. Literature regarding digital transformation in universities is centered around the utilization of LMS, student information systems, cloud and analytics for enhanced teaching and learning and administrative efficiency. Digital transformation is considered a socio-technical term of technology and people, processes and culture. Studies show that successful digital transformation gives way to improved institutional agility, enables personal learning and fosters data-driven decision making.

However, cybersecurity becoming as critical challenge coming with digitalization. Cyber threats are on an upward ticking trend from around the world as they are rated as one of the most frequently attacked sectors due to its open networks, diverse user base and critical data assets (Smith & Rupp, 2020). Common Threats Responsibility: Phishing Ransomware

Credential Stealing Internal Threats External Denial of Service (DoS) Research point out the lack of exhaustive cybersecurity measure taken by the academic institutions that arise from the limitations of resource priority of other work and low security awareness among the users.

Regionally, the patterns hold under the studies are done in South Asia. Indian and Bangladeshi universities report online examination systems susceptibility and non-secure network infrastructures, not to mention absence of consistent surveillance. (Chen & Zhao, 2020; Zhang & Sun, 2021)Cybersecurity policy lapses and poor enforcement of cybersecurity policies are commonplace and institutions leave old systems and have weak involvement mechanism to tackle access.

In Pakistan, on the basis of research on digital transformation on higher education, there are signs of incremental adoption of digital platforms suggested within higher education as well as low level of readiness on addressingimpjos jntm en stsfe, fullyfilling a sketch on the challenges of cybersecurity. Studies note that many HEIs do not have full-fledged incident response strategies or risk assessment frameworks, but go with simple security tools. IT governance structures often have no clear cybersecurity mandates and a negligible amount of budget is made for security. Awareness programs to the students and staff are very rare which leads to phishing susceptibility and poor password practices.

Barriers to cybersecurity in HEIs include lack of technical expertise, insufficient training, policy fragmentation and absence of national standards for educational cybersecurity.(Chen & Zhao, 2020, Zhang & Sun, 2021) On the other hand, success factors include institutional leadership commitment, incorporation of cybersecurity into curriculum, partnerships with cybersecurity firms as well as investment in secure infrastructure.

Overall, need to align the digital transformation initiatives with cyber security strategies with governance, capacity building, awareness among users, policy coherence and continuous monitoring are taken into cognizance from literature. However, scanty research exist specifically looking at Pakistan's higher education which call for empirical research on the interaction between digital transformation and cybersecurity challenges in Pakistan in terms of higher education.

Methodology

This study utilizes a mixed method in order to know the digital transformation in practice and cybersecurity issues in HEIs of Pakistan in the form of quantitative studies. The mixed-methods approach combines data from both quantitative and qualitative methods to provide both breadth and depth of understanding -- quantitative data helps see which adoption patterns are occurring and what perception of cybersecurity readiness is, while qualitative data allow the expert to look for context information from those who are responsible for the digital systems and security policies.

The quantitative phase was a structured survey conducted amongst a stratified sample of stakeholders in a number of universities. Participants included students, faculty, administrative staff, and IT professions and all came from different disciplines and types of institutions (i.e., public and private). A total of 420 answers to the survey were collected. The survey instrument was created depending upon validated scales from motion pictures previous research on digital transformation and cybersecurity readiness. The questionnaire was carried out to examine the perception of the respondents in terms of usage of digital platforms, frequency of cyber incidents experienced, awareness about the cyanber security policies, confidence towards security measures provided by the institution and perceived adequacy of cyber security training received by the respondents. Survey items were measured using a five point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

The qualitative phase involved 20 semi-structured interviews with the experts using interviews with university Chief Information Officers (CIOs), cybersecurity consultants and policy specialists. Interview questions were designed to find out about institutional mechanisms to digital transformation, cybersecurity governance models, incident response methodologies, workforce and student training initiatives, perceived security enhancement barriers and recommendations for enhancing resilience. Interviewees were recruited using purposive sampling with the aim of having people who are directly involved in the decision and implementation of digital systems and security initiatives.

In order to insure reliability and validity, the survey instrument was pre-test pilot tested in a group of students and staff identified from a small sample of students and staff from a representative institution. Feedback from the pilot presented

information to make small revisions to questions wording and structure. Cronbach's alpha was used for measuring important constructs (e.g., cyber security awareness, level of adoption, level of security confidence) and all results of scales obtained were greater than 0.80, suggesting that index validity was high. Confirmatory factor analysis (CFA) was employed for the validation of the constructs. For the qualitative data at hand, interview transcripts were coded following the principles of thematic analysis, which allowed for the identification of recurrent patterns, common challenges and divergent perspectives. NVivo software was used to code and organize qualitative data.

Data analysis tasks have been done by using the descriptive statistics, to paragraph the digital demographics and the centralities of the sample and the digital adoption and cybersecurity readiness indicators. The results from inferential analyses were correlation and regression analysis done to find the relationship between digital transformation levels and perceived cybersecurity risk. Qualitative findings were complementary to the quantitative findings that they uncovered subtle details of institutional practice, governance challenges, resource constraints and cultural factors that affect cybersecurity preparedness.

Attention to ethical considerations was of supreme importance. The participants were explained the aims of the study, confidentiality and anonymity was guaranteed and consent for participating was given in a voluntary manner. Data have been stored in safe manner and use of identifier removed in order to protect the privacy. The use of quantitative and qualitative data together through triangulation of data, has enhanced the robustness of the findings that encompasses thorough evaluation of the combination of digital transformation initiative with cybersecurity challenges in HEIs in Pakistan.

Results and Discussion

The outcomes display that virtual transformation has carried out massive momentum amongst HEI in Pakistan but linking cyber safety readiness varies lots in keeping with the stakeholders and HEIs. Survey records shows that virtual platforms -- in bureaucracy together with Learning Management Systems (LMS), pupil facts systems, in addition to digital collaborations -- are being extensively used for instructional delivery, management and communication. Respondents indicated robust stages of virtual adoption with the suggest rating falling to 4.21 (SD =0.65) on virtual platform usage. However, cybersecurity signs that encompass institutional preparedness (imply=3.02; SD=0.91) consciousness of cybersecurity policies (suggest=2.95; SD=0.87) and self assurance in safety features in place (imply=3.08; SD=0.89) have been extensively decrease indicating gaps to virtual use and protection preparedness.

Table 1. Descriptive Statistics of Key Variables

Variable	Mean	Standard Deviation
Digital Platform Usage	4.21	0.65
Cybersecurity Awareness	3.40	0.78
Confidence in Security Measures	3.08	0.89
Institutional Cybersecurity Preparedness	3.02	0.91
Frequency of Cyber Incidents	3.51	0.83

Correlation analysis uncovers serious relationships between the digital transformation and cybersecurity dimensions. For example, the more digital platforms are used, the more frequent cyber incidences occur ($r = 0.47$, $p < .001$), suggesting that the more one is digitally dependent the more one's risk of exposure increases. Cybersecurity awareness has a positive correlation with confidence with security measures ($r = 0.52$, $p < .001$) - which can be interpreted as meaning if stakeholders know more about security threats and protocols, they are more confident in institutional security readiness.

Results of regression methods give insight on predictors of cybersecurity confidence. Institutional preparedness was found to be the most significant predictor followed by cybersecurity awareness ($b = 0.35$, $p < .01$). Significantly, higher digital

platform usage did not predict confidence in one's security in a significant manner, and demonstrate that adoption of digital platforms is not an assured cybersecurity resilience factor.

Table 2. Regression Results Predicting Confidence in Security Measures

Predictor	Beta	p-value
Institutional Preparedness	0.41	< .001
Cybersecurity Awareness	43	< .01
Digital Platform Usage	0.35	0.08

These traits are similarly elaborated on through the qualitative interviews. Experts stated maximum universities have invested in virtual structures, however didn't broaden sturdy cybersecurity frameworks. One CIO stated: "We have true LMS and on-line offerings however we do not have a coherent cyber safety coverage and committed protection operations center." Many instances incidents are sorted advert hoc. Another interviewee highlighted schooling shortcomings: "Faculty and college students are engaging in enterprise on-line normal but infrequently all and sundry is ever educated to recognize the idea of phishing assaults or a way to shield their accounts." These insights are consistent with the survey end result that suggests that cybersecurity focus is slight however now no longer contemplated in assured sufficient protection practices.

Interviewees additionally raised institutional barriers - restricted budgets for protection infrastructure, opposition among the instructional and IT devices and lack of professional cybersecurity professionals. Some universities outsource fundamental IT aid and haven't any essential in-residence information for superior danger in detection and reaction. These structural demanding situations are a part of a bigger trouble of low ranges of institutional preparedness, and are a mirrored image of systemic troubles of one's potential to combine powerful cybersecurity.

Overall the outcomes paint a photograph of the way the virtual atmosphere is adopting, however cybersecurity maturity, in general, is sluggish. Digital transformation endeavors have brought about an boom withinside the use of on line structures for academic coaching and studying and on-line control, however, with out commensurate investments in guidelines, focus, technical controls and governance mechanisms, establishments are susceptible to cyber threats.

Discussion

The findings of the have a look at factor to the truth that despite the fact that virtual transformation is making inroads in Pakistan's better training establishments, there's a stability wherein is choppy and is underdeveloped withinside the vicinity of cybersecurity preparedness. The excessive degree of virtual structures utilization display that universities include ICT for each the coaching reason and the executive cause, however, this virtual dependence additionally result in a better degree of publicity to cyber threats like phishing, malware and unauthorised access. These developments are supported, at the worldwide degree, via way of means of the studies at the want to higher safety ecosystems because of superior connectivity and the usage of on line offerings that still boom institutional assault surfaces.

One essential statement stands proud and it is the virtual adoption vs. self assurance in safety. Survey records display that have an effect on conversion (i.e. tremendous use of virtual systems isn't always equated with a self assurance in a safety measure) can be going on withinside the absence of concomitant investments in protection infrastructure and governance. This locating is steady with the literature, which recognises virtual transformation and cybersecurity as interdependent however separate regions that require coherence in place of silos for strategy.

Furthermore, proof confirmed that institutional preparedness and cybersecurity focus have been critical predicting elements of security features self assurance. Institutions having extra preparedness architecture -- including incident reaction plans, safety rules and devoted employees and tracking controls -- convey better tiers of self assurance amongst stakeholders.

Similarly, while college students, school, and team of workers individuals have a better recognition of cyber dangers and the approaches to mitigate those dangers, there's better agree with withinside the safety posture in their institution.

Qualitative insights factor out organization's subculture and ability in preparedness of cybersecurity. Experts careworn that it's far important that virtual transformation is followed via way of means of management commitment, strategic making plans and non-stop education programs. Without those factors virtual structures can correctly paintings however may also be susceptible to being exploited. The absence uniformity of cybersecurity rules coupled with the ambiguous dependence on casual modes or reactive cybersecurity measures is the extra gasoline to the institutional weaknesses.

Another massive subject is the aid constraint of HEIs. Budgetary constraints normally imply that establishments must pick among fundamental IT infrastructure and protection improvements. The loss of devoted cybersecurity devices and absence of abilities do now no longer permit for proactive danger control and that manner establishments are left with out a cybersecurity unit in their personal and are connected with outside companies or have familiar IT body of workers with little or no protection knowledge.

The virtual divide, specifically in capabilities and attention of users, additionally contributes to the final results of cybersecurity. Students and college individuals which might be extra digitally literate are well-geared up to determine the hazard including phishing emails and suspicious links, whilst people who aren't as uncovered to secure safety practices could inadvertently open structures and/or information. This calls for an all-pervasive mindset to focus programmes and obligatory schooling modules embedded withinside the academic and administrative structures.

In conclusion, it is evident through discussion that the challenges of digital transformation and cyber security are moot and interlinked. Dealing with cybersecurity is not just a matter of policy and deploying IT security tools, it is a complex process where policy making, resources, awareness, capacity and regime changes are required. Institutions must step up and ensure that cybersecurity is more than a technical problem and respond to it by placing its importance as an organisation if digital transformation is to be sustainable and secure.

Conclusion

This piece of research discussed the level of digital transformation and cybersecurity issues existing in the country's higher education institutions. Findings show that although digital platforms have been widely used for teaching, learning and administrative purposes, cybersecurity preparedness is still low and unevenly spread across stakeholders and institutions. The research is stressing on the fact that digital transformation and cybersecurity must be pursued hand-in-hand or else the campuses will suffer from increased cyber risks if only digital transformation is adopted without strong security frameworks.

The studies provides to a higher information of the usage of virtual structures as nicely nature of cyber protection vulnerabilities inherent withinside the better schooling environments. Survey proof indicates that at the same time as there's a cushty tolerance via way of means of an amazing variety of stakeholders - particularly college students and faculty - for the use of virtual equipment, and the usage of on line systems, there may be a loss of religion in institutional potential to reply to a cyber danger. This hole factors to a systemic hassle the primary virtual get right of entry to, provider provision however inadequate funding into governance, coverage and establishments to make certain the safety of these virtual offerings.

The outcomes endorse that institutional preparedness and cybersecurity cognizance are essential enablers of stakeholder self belief in protection measures. Institution that has a clean proof of regulations and incident reaction plans and protection role stand a higher hazard to prevailing person trust. Likewise, in preference to the assumption, stakeholders who've more potent cognizance of cybersecurity standards are probable to illustrate more potent emotions of institutional resilience. These findings are constant with the ones from round the sector which stresses the significance of governance and schooling as a whole lot because the technical controls which are a part of securing virtual ecosystems.

Despite the usage of virtual, there are brilliant demanding situations as consistent with the data. The mild degrees of cybersecurity focus and self assurance are signs and symptoms of ongoing vulnerabilities - crowned up via way of means of useful resource limitations, competing priorities and shortage of get admission to to specialised expertise. Qualitative

interviews depict that many establishments do now no longer have a coherent cybersecurity method and that practices are regularly scattered throughout special departments or that practices are primarily based totally on advert hoc reaction to incidents in place of proactive risks.

The virtual divide is likewise worried withinside the effect of cyber protection in that people with lesser tiers of virtual literacy can be greater vulnerable to falling for scams via phishing, have weaker practices with passwords and different danger behaviors which can compromise institutional systems. There are extensive coverage implications in addressing those troubles with the want for complete techniques that cross past imposing generation to cope with potential constructing of all network participants as properly. There is apparent want for countrywide pointers and requirements in cybersecurity for schooling and those want to be supported with the aid of using institutional mandates and frameworks. Higher training associations, regulatory our bodies and era companions will ought to collaborate to expand cyber governance fashions with clean roles, duties and systems of accountability.

In addition to formal rules, investments in stable infrastructure (referred to which include firewalls, intrusion detection systems, encryption protocols and protection monitoring) are critical. These equipment want to be supported with the aid of using non-stop schooling programmes for the administrators, colleges and college students and lively communique campaigns to re-non-stop stable practices.

Finally, it's miles that fee incorporated incident reaction abilities can offer that is made spotlight through the studies. Cybersecurity activities are unavoidable, given the complexity of the virtual global and plans had to be in location for preparedness and reaction are crucial in tackling damage, making sure continuity of offerings and maintaining trust. Institutions must put in force mechanisms that permit them to discover threats withinside the fastest way possible, which will speak them, incorporate them and get over them.

In conclusion: Pakistan's better training quarter is now at a disaster factor in its adventure of virtual transformation. The advent of virtual structures has added approximately extra opportunities for training and administration, however cybersecurity demanding situations are a first-rate danger for the sustainability, integrity and high-satisfactory of those innovations. By taking cybersecurity as much as this stage as a really perfect and strategic priority - with complete grounding in governance, consciousness, infrastructure and coverage coherence - HEIs can higher shield their groups and unharness the ability of the entire promise of virtual transformation.

Recommendations

- Develop and implement HEI wide policies on topics related to cybersecurity
- Create cybersecurity dedicated units in universities
- Invest in secure ICT infrastructure (firewalls and use an IDS, and use encryption)
- Conduct frequent cybersecurity studies/penetration testing
- Continually provide cyber security training to students, faculty and staff
- Make Cybersecurity Solidarity Awareness in Different Courses
- Create national standards & frameworks for educational government from cyber security
- Co-operate nationally for intelligence on cybersecurity threats
- Undertake person consciousness campaigns which might be geared toward phishing and social engineering
- Provide unique budgets for making plans and reaction to cybersecurity threats
- Make incident reaction groups and write formal reaction protocols
- Support multi-issue authentication of all institutional systems
- Implement steady governance of clouds of carriers the use of seller SLAs
- Monitor compliance with the assist of third-birthday birthday celebration safety assessments

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