

Technological Innovations and Their Impact on Alumni Engagement and Relationship Management in Higher Education

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Abstract

The evolving digital ecosystem in higher education institutions (HEIs) has positioned alumni as critical stakeholders in institutional development, mentoring, and academic community building. Despite the growing adoption of digital platforms, empirical evidence on technology-mediated alumni engagement—particularly in the context of Indian HEIs—remains limited, creating a gap in understanding effective digital engagement strategies. This study aims to examine the role of technology-enabled alumni engagement practices in HEIs of Punjab, India, by analyzing the relationship between demographic characteristics, digital interaction patterns, and perceived usefulness of technological tools in strengthening alumni–institution relationships. A mixed-method research design was employed, integrating quantitative survey data collected from 60 alumni across multiple HEIs with qualitative insights from two institutional representatives. Quantitative analysis involved descriptive statistics, Chi-square tests, and correlation analysis to evaluate associations among demographic variables, online engagement frequency, and satisfaction with digital tools. Qualitative data were used to contextualize and interpret institutional perspectives. Findings indicate that over 80% of alumni prefer digitally supported engagement mechanisms, with LinkedIn and WhatsApp emerging as the most utilized platforms. Chi-square analysis reveals significant associations between alumni participation and year of graduation, program type, and campus placement history. Correlation results demonstrate a positive relationship between frequency of digital interaction and satisfaction with engagement initiatives. Qualitative evidence highlights strong appreciation for mentorship programs, online seminars, and professional networking, while identifying incomplete alumni databases and limited institutional support as key challenges. The study underscores the strategic importance of digital technologies in enhancing alumni affiliation, professional networking, and inter-generational collaboration. It recommends integrated digital engagement systems, continuous data updating, and personalized communication strategies to foster long-term alumni loyalty and mutually beneficial institutional relationships.

KEYWORDS

Alumni engagement, digital platforms, higher education, Punjab, technology adoption, relationship management, LinkedIn, alumni networks

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DATA/CODE AVAILABILITY

Data and code are available from the corresponding author upon reasonable request.

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1 Introduction

Alumni engagement has become one of the dimensions of institutional success and sustainability in the vibrant environment of contemporary higher education. Alumni are not mere ex-students but permanent representatives of the legacy, reputation and values of their alma mater. Great alumni engagement would help the institution to develop in terms of mentoring, networking, donations, and interventions in academic and professional projects. Historically, the relationships among the alumni were upheld by holding a reunion periodically, a newsletter, and face-to-face meetings. Nevertheless, technological advancement and the emergence of online communication systems have changed the way higher education institutions (HEIs) reach out to their graduates. Within the framework of the Punjaba region known to be the most vibrant regarding educational matters and the swiftly growing higher education industry, the context of the digital tool influence on alumni engagement has gained a special importance [1].

Institutional outreach boundaries have been transformed by the emergence of digital technologies. This has changed with the introduction of social media and social media management software, virtual channels of engagement and higher education institutions are now afforded more opportunities than ever before to maintain and nurture their relationships with alumni communities. The ability to interact on a continuous basis, professional networking and joint work is possible on platforms like LinkedIn, Facebook, and alumni portals of the institutions without geographical constraints. The technology enabled participation can enable institutions to grow a feeling of affiliation and emotional attachment between alumni as well as providing a means of mentoring, sharing of knowledge and building communities. It is also important to note that in a world where higher education enters global competition and growing accountability, these kinds of connections can be a key factor in improving the reputation of the institutions, the employability of graduates, and stakeholder confidence [2].

The state of higher education in Punjab is a good reason to investigate the subject of technology-based engagement of the alumni. The state also has a rich concentration of both state and privately owned universities, independent colleges as well as professional institutions that accommodates a variety of students in an assortment of academic fields. The region has experienced increased digital infrastructures and incorporation of information and communication technologies (ICT) in the academic processes in the last decade. In Punjab there are numerous institutions that have formed alumni cells or offices that are focused on keeping in touch with alumni. However, the measures and initiatives of such programs are uneven. Whereas, some schools have adopted an all-encompassing approach to digital strategy, including specific alumni applications, virtual mentoring, and online fundraising campaigns, others continue to depend on the traditional means of communication, which restricts their potential to establish end-lasting relationships with international alumni networks. Such an unequal application raises the need to conduct an organized research on how technology could be strategically exploited to strengthen alumni relations in the regional setting [3].

Besides, technology has changed the expectations of the alumni themselves. The current graduates want to be provided with more individualistic, adaptive and interactive engagement. They require institutions to offer virtual platforms to professional development, learning, and social service. At the same time, online communication between alumni and current students is an excellent opportunity that allows the latter to get a glimpse of the real world, career advice, and get in touch with the industry. Technology is therefore a unifying factor between the generations between the past, present and the future members of the academic society. Nevertheless, in spite of such benefits, digital fatigue, data management problem, insufficient institutional resources, and the necessity of constant innovation in engagement strategies are also the challenges that institutions have to deal with. It is crucial to have insights into the role of these factors in alumni engagement and institutional performance to develop sustainable systems of engagement [4].

The studies about the area of alumni relations have highlighted the increasing significance of digital change in higher education. To monitor the engagement patterns of the alumni and personalize communication strategies, institutions all over the world are moving towards the utilization of data analytics, artificial intelligence, and customer relationship management (CRM) systems. Efforts such as online directories of alumni, virtual networking functions, and web-based fundraising efforts have become popular in India. However, a gap in regional literature related to higher education institutions in Punjab, which exist in the context of specific socioeconomic and cultural areas, still exists. The robust presence of a diaspora and global alumni in Punjab provides it with unparalleled opportunities of international cooperation, building of the institution, and reaching people in the community when properly exploited via technology[5].

This paper thus attempts to investigate the use of technology based strategies that higher education institutions in Punjab use to attract and retain their alumni, determine the effectiveness of these strategies and the best practices they can adopt in building sustainable relationships. Through the analysis of the currently available digital tools and practice, like alumni portals, virtual events, social media networks, mobile applications the study seeks to give a thorough picture of how institutions can build substantial and enduring relationships with their alumni. The paper will also examine the impact of these technological projects on alumni loyalty, their involvement into the institutional activities and the relationships between them and the current students.

Moreover, this study will take into account the barriers that institutions have to use and sustain digital engagement systems, such as the resource appropriation, data privacy, content relevance, and technological literacy issues. The paper will as well examine how institutional leadership and alumni offices can help to promote the culture of unremitting digital interactions. Through the synthesis of these findings, these studies are aimed at providing practical recommendations and best practices, which can inform policymakers, administrators, and educators on how to improve alumni engagement strategies with the use of technology.

2 Literature Review / Background

In the last twenty years, alumni engagement has been transformed to a strategic aspect of higher education management compared to the ritual institutional practice. Initial researches in the area took the conceptual approach where alumni relations were considered to be a support activity whose primary concerns were fundraising and organization of events. Subsequently, however, other research came to appreciate the broader role of alumni in being able to add value to the institutional reputation, employability promotion, and community development. The scholars have stressed more and more that alumni are not former students but life long stakeholders whose engagement enhances the academic ecosystem. Such a change in opinion resulted in an emerging literature exploring ways in which the strategies of engagement can be used to establish a long-term relationship between the graduates and their alma mater, as well as those between the graduates and the current students[6].

Some research works have focused on the content and size of alumni engagement. Conventional approaches to engagement divide it into emotional, social, professional and financial. Studies have shown that emotional attachment the sense of belonging and pride in one institution tend to come before other participation. Social interaction, manifested in reunions, events, and volunteerism, is useful in keeping connected, and professional interaction can be useful in sharing of knowledge, mentoring, and career growth(Gupta et al., 2025). Although traditionally regarded as the center of alumni relations, financial contribution is currently regarded as one of the results of the commitment in relationships in general. The empirical results of the studies conducted in the higher education systems show that in case institutions have the stable communication, recognize the achievements of the alumni, and incorporate them into the academic

or career programs, the engagement becomes sustainable and multidimensional [7].

Since organizational behavior is in the digital transformation, researchers have examined the effects of digital transformation on alumni relations. The study of technology-mediated engagement shows that digital systems have made institutions to redefine their interactions with graduates, and this interactivity has changed the geographical and time constraints. Universities have been able to stay in close touch with their scattered communities of alumni through the integration of social media, online portals, and dedicated alumni management systems[8]. Research has demonstrated that social networking sites such as LinkedIn, Facebook, and Twitter are informal and yet effective platforms of interaction, professional networking, and storytelling by the institution. These virtual communities also prompt the alumni to update and discuss and keep up with what is happening in the institutions, which helps them to maintain their attachment to the alma mater. It is also observed that engagement through the digital networks becomes democratic because it allows involvement of alumni who would not otherwise be able to attend physical events because of distance or time limitations[9].

Simultaneous studies of both alumni management systems and customer relationship management (CRM) tools reveal the increased significance of data analytics in engagement. Organizations that use CRM are in a better position of monitoring participation and grouping and ranking alumni according to interests and tailoring communication plans[10]. A number of studies point out that data-driven personalization increase engagement because the alumni feel acknowledged and appreciated. The shift towards specific newsletters to the targeted digital communication is a transition towards relationship-based communication as opposed to transactional outreach. Moreover, virtual events, webinars, and online conferences have become more popular, particularly during the post-COVID-19 period, when the institutions of higher learning were seeking alternative means of maintaining contact with their communities. It has been provided by scholars that these online experiences can be equal to the in-person interactions as long as they are designed to encourage interaction and learning together [11].

Another significant literature strand has been found to be the relationship between alumni involvement and the present student development. Numerous studies point out that alumni-student relationships play an important role in career development, mentorship and forming institutional identity. Digital technologies have enabled the creation of mentor programs, online forums, and collective projects to unite present students with professional alumni around the world[12]. The empirical evidence regarding the creation of these digital mentorship ecosystems has been consistent in the fact that more employable students, improved alumni loyalty, and cohesive institutional culture are observed in institutions that foster those ecosystems. Besides, digital media exposure to alumni success stories increases the motivation of students and strengthens the image of an institution as a kind of life-long support system [13].

Although the hype about digitalization is great, scholars warn that the use of technological tools does not ensure engagement. There are a number of studies that have found out the main factors that can determine the success of technology-driven alumni programs. The organizational leadership, the strategy and the purpose are always cited as the pre-requisites. In the absence of a clear engagement strategy, online efforts usually turn into sporadic and disjointed. The importance of user experience and accessibility can also be mentioned by the research [14]. Difficult log-in, out-of-date sites or inapplicable information is likely to deter engagement. Quite to the contrary, simplicity, individualization and interactivity are enticing to continued engagement. The other theme that has repeatedly been present in the literature is the perceived value. There is an increased involvement of alumni when they feel that they can get some real returns in the form of professional networking, mentorship, access to institutional resources, or acknowledgment of accomplishments. Therefore, to establish successful digital interaction, a balance should be created between institutional and alumni expectations [15].

The other determinant of participation has been found to be social influence. Research has indicated that peer-to-peer or faculty encouragement of engagement programs on the web

boosts participation by the network effect. Conversely, digital literacy, concerns relating to the privacy of data, and the absence of consistent followups are some of the barriers that deem these initiatives to be unsuccessful. According to researchers, electronic interactions require constant content creation, database management, and professional person resources that not every institution can afford. Thus, digital inequality between institutions is a challenge, especially in the developing regions [16].

This is different in the Indian institution of higher learning. Studies have shown that whereas major national institutions have done well in adopting the holistic alumni portals and digital communities, most regional and private institutions are still in the infancy stages of adoption. The literature determines the following barriers to technology-enabled engagement in India: ineffective data management systems, disjointed alumni records, and a culture within the institution focused on lifelong connection. Nevertheless, research also points at new positive developments, including online alumni gatherings, online mentoring, and the increased impact of social media on community formation. The fast proliferation of internet connectivity and use of smartphone has made even more avenues open to outreach. In Indian universities, the importance of alumni participation is increasingly realized as a means of institutional prestige, as well as the ability to employ and collaborate in research with students [17].

On top of this general national background, there is very limited research on the practices taken by higher education institutions in Punjab. Some initial findings indicate that although alumni associations and social networks are established in some universities in Punjab, the systematic strategies of digital engagement have not yet reached any unified state [18]. The level and the success of digital outreach is affected by the following factors: resource shortage, the leadership orientation, and the distribution of Punjabi graduates across the globe. Cultural norms also have an influence on alumni participation, there is evidence that alumni engagement is usually event-based as opposed to ongoing. The gap in the literature thus reveals a research gap in the region with respect to understanding how institutions can embrace technology better in Punjab in order to maintain long term relationships with alumni and students [19].

The last research has started to consider more sophisticated technological solutions like artificial intelligence, data analytics, and virtual reality in the sphere of alumni relations. Engagement potential is being estimated using predictive analytics and it is being used to design personal campaigns, and virtual and hybrid reunions are transforming postpandemic engagement approaches [20]. Certain researches suggest gamifications like digital badges, recognition points, and leaderboards as a means by which they may improve motivation and involvement in alumni communities. Although such innovations are made, scientists emphasize that there should be the human connection. Online platforms are considered to be enablers and not replacements of real relationship building. To create an effective engagement, it is necessary to achieve a combination of emotional appeal, shared values and mutual benefit that is mediated by technology.

3 Methodology

The current study took a mixed-method exploratory research approach to examine the role of technology-mediated relationship management and alumni engagement in institutions of higher learning in Punjab, India. It is believed that the mixed-method approach was suitable to meet the quantitative trends in alumni engagement as well as to include the institutional points of view which can be used to explain the observed trends. The quantitative element was the main source of empirical data, and the qualitative input was referred to in order to contextualize and interpret the results of the survey.

The research was carried out in two institutions of higher learning within the state of Punjab and the institutions were purposely selected based on the existence of formal systems of alumni engagement and the utilization of digital communication channels. A total of 60 alumni were

chosen as 30 alumni of each institution were chosen after a purposive sampling method. The respondents also had a varied demographics in terms of gender, age bracket, year of graduation, discipline and employment status. Since the research was exploratory in nature, the given sample size was deemed appropriate to detect the patterns and relationships but not to make generalizations.

A structured online questionnaire was used to obtain primary quantitative data that were collected through administering the questionnaire to the alumni of the two institutions. The questions in the questionnaire were connected to the demographic data, the rate and the way of institutional communication, the involvement in the alumni activity, the sense of effectiveness of the digital platforms, the emotional attachment towards the institution, the satisfaction with the alumni engagement activities, and intentions to engage in the future.

The main goal of the research: alumni engagement, satisfaction, communication effectiveness, and the perceived effectiveness of digital platforms were operationalized in terms of five-point Likert-scale rates with higher scores reflecting stronger agreement, greater satisfaction, or even greater perceived effectiveness. Alumni engagement was measured with the help of variables like the frequency of involvement in alumni events, contact with the current students, and attachment to the institution. The outcome of the measurement of satisfaction was done regarding the level of communication and the experience of alumni engagement. Each and every response was numerically coded so that it could be analyzed statistically.

The analysis of the quantitative data was performed with the use of descriptive, inferential, and correlational statistics. The demographic characteristics and overall engagement patterns were summarized using descriptive statistics, such as frequencies and percentages. The chi-square tests of independence were used to identify the relationship between categorical demographic variables (age group, employment status, etc.) and the results of engagement, frequency of communication, and attendance of alumni activities. Besides that, correlation analysis (rank correlation coefficient of Spearman) was used to test the strength and direction of the relationships between the most important ordinal variables (including emotional connection, satisfaction with communication, perceived effectiveness of digital platforms, intention to stay connected with the institution). This analysis was useful in evaluating the existence of stronger alumni engagement and future commitment with higher levels of satisfaction and perceived effectiveness.

In order to supplement the survey findings, short semi-structured interviews with one representative of each university, usually engaged in alumni coordination or placement, were conducted, based on qualitative data. The interviews concentrated on the institutional practices of alumni engagement, the application of the digital platform, issues with data management of alumni, and the perceived results of digital interaction. The qualitative data were thematically examined and incorporated into the discourse to provide context to the quantitative findings and clarify them instead of being independent generalizable data.

The study did not violate any ethical consideration. The respondents had given voluntary participation, had to have informed consent and confidentiality and anonymity had been maintained. The information was utilized as a scholarly research. The results are construed as suggestive in consideration of the few institutions as well as the exploratory nature of the design.

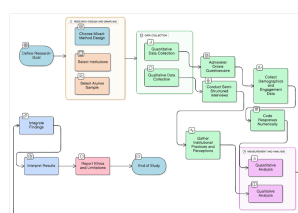


Figure 1: Research Methodology

4 Data Analysis and Interpretation

Sixty alumni and two institutional officials of sampled higher education institutions in Punjab have been interviewed to learn how the strategies based on technology impact on the engagement and relationshipbuilding between alumni. Structured online questionnaires and short interviews with institutional officials, two alumni coordinators and a placement officer, were used to get the data. The discussion uses both quantitative and qualitative knowledge to create a holistic view of the digital alumni engagement practices in the region.

The gender, age, year of graduation and employment status of the alumni participants are diverse as shown in the demographic analysis. Among the sixty respondents, thirty five were male and twenty five were females which is a fair gender balance. Majority of the participants were those aged 26-30, and the next age group is 21-25, meaning that the recent graduates represent the most active group in the digital alumni networks.

Table 1: Demographic Profile of Alumni Respondents (N=60)

| Parameter | Category | Frequency | Percentage (%) |
|-------------------|-------------------------|-----------|----------------|
| Gender | Male | 35 | 58.3 |
| | Female | 25 | 41.7 |
| Age Group | 21–25 years | 18 | 30.0 |
| | 26–30 years | 28 | 46.7 |
| | 31–35 years | 14 | 23.3 |
| Graduation Year | Before 2015 | 7 | 11.7 |
| | 2016–2020 | 28 | 46.6 |
| | After 2020 | 25 | 41.7 |
| Employment Status | Employed | 46 | 76.7 |
| | Self-employed | 7 | 11.6 |
| | Pursuing Higher Studies | 7 | 11.6 |

Gender Distribution of Alumni Respondents

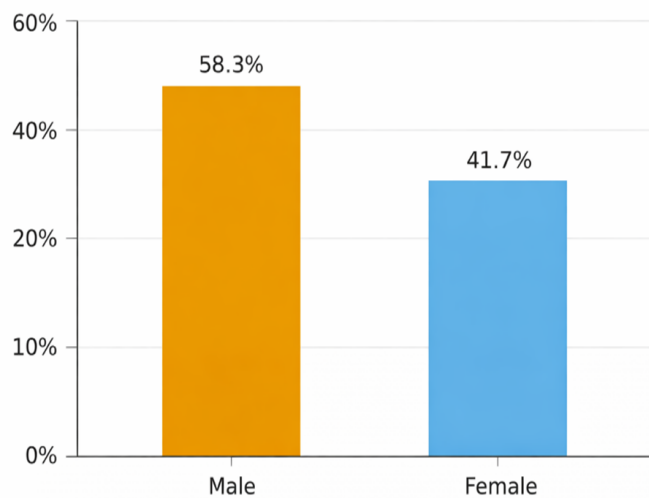


Figure 2: Gender Distribution of Alumni Respondents

Age Group Distribution of Alumni Respondents

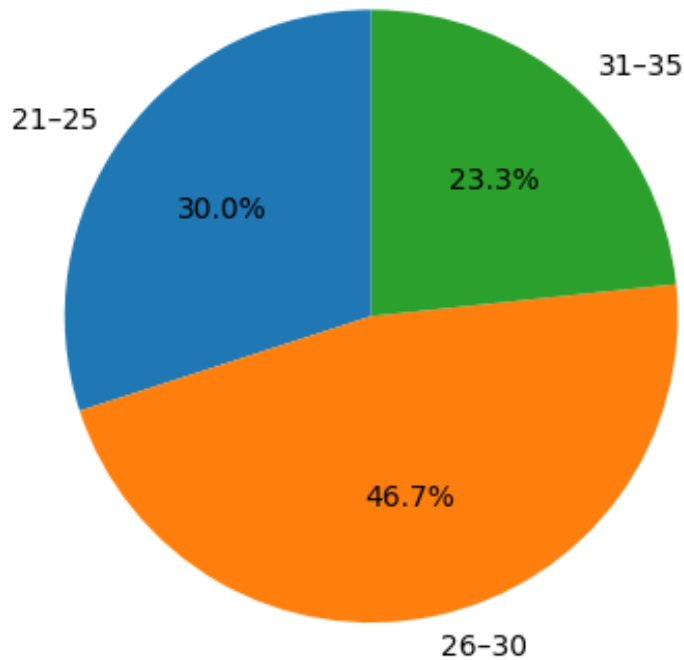


Figure 3: Age Group Distribution of Alumni Respondents

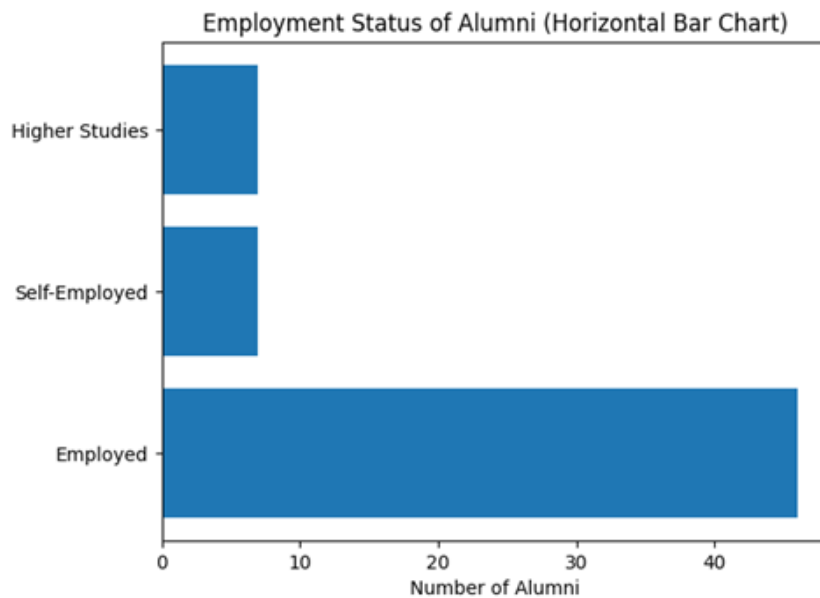


Figure 4: Employment Status of Alumni

The employment pattern emphasizes that the number of respondents who are employed professionals stands at 76.7 percent which indicates that the alumni base is professionally active and digitally connected. The officials affirmed that such professionals would be the most probable to be involved in digital mentorship and institutional partnerships.

When questioned about the digital platforms that are utilized to engage with the alumni,

the findings indicate that LinkedIn (90%), WhatsApp (75%), and Facebook (70%) carry the day but Email (65%) and Institutional Alumni Portals (60%) are also popular. This proves the importance of casual and convenient mediums toward keeping alumni contacts alive.

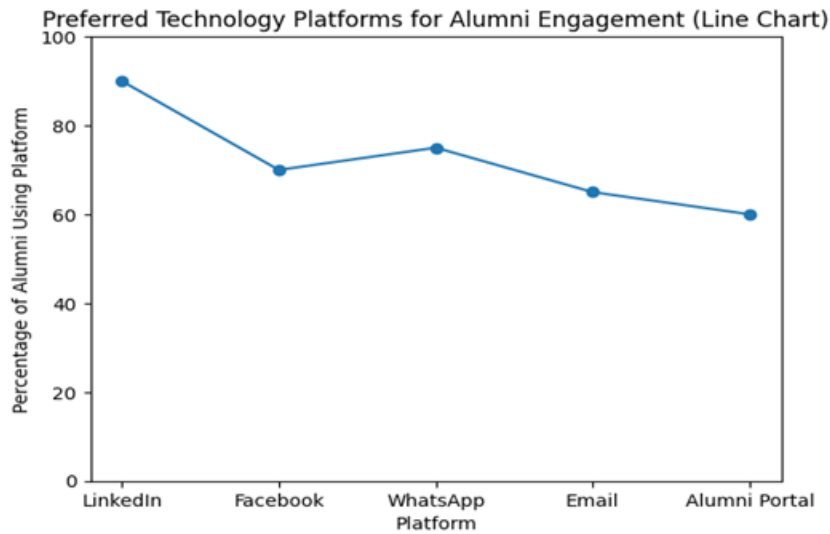


Figure 5: Preferred Technology Platforms for Alumni Engagement

A majority of the alumni indicated that they are updated on what is happening in the institution mainly on WhatsApp groups and LinkedIn pages. This result was confirmed by institutional officials, who also mentioned that such platforms are economical and have extensive coverage.

As far as the frequency of online communication is concerned, twentyfive alumni documented having it once a week, twenty once a month, ten once in a while, and five seldom. This implies that most of them have consistent virtual communication with their alma mater.

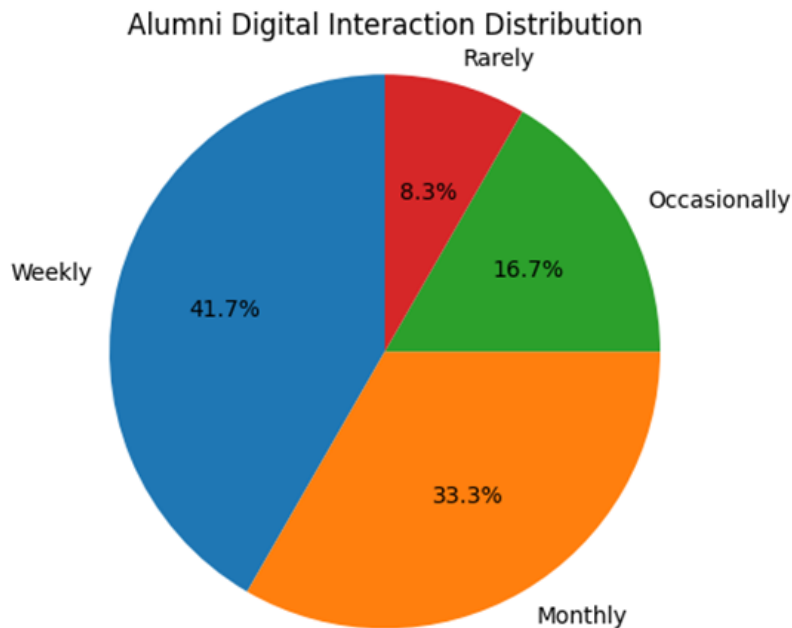


Figure 6: Frequency of Alumni Digital Interaction

The respondents rated different institutional initiatives in order to comprehend the strategies

that engage the alumni most of all. The most effective tools were Webinars (85%), Mentorship Programs (80%), and Networking Events (75%), then came Placement Support (70%), Fundraising Drives (55%).

Table 2: Effectiveness of Alumni Engagement Strategies

| Strategy | Rated Effective by Alumni (%) |
|---------------------|-------------------------------|
| Webinars | 85 |
| Mentorship Programs | 80 |
| Networking Events | 75 |
| Placement Support | 70 |
| Fundraising Drives | 55 |

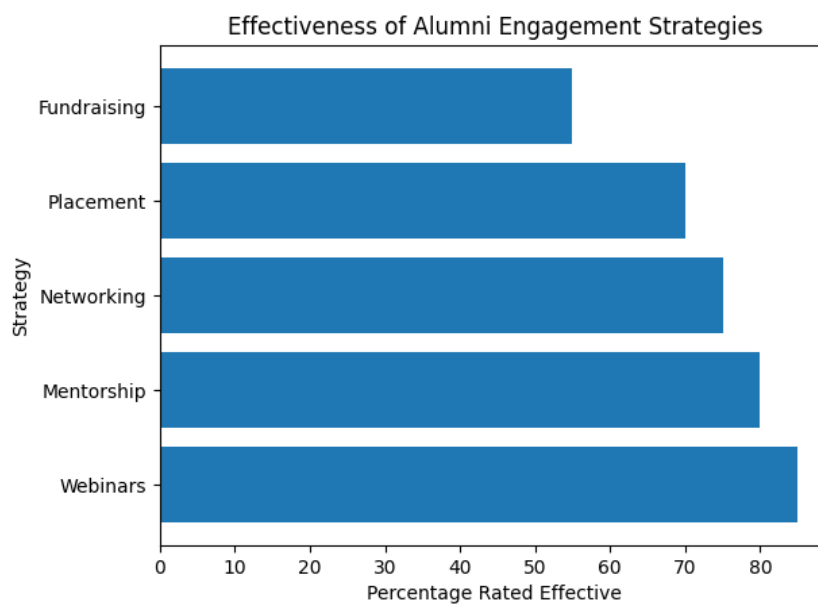


Figure 7: Effectiveness of Alumni Engagement Strategies

According to the officials of the institutions, online events, webinars and LinkedIn based mentorship programs have enhanced engagement significantly. They also found that programs which offer concrete professional gain to the alumni have more participation and loyalty. Nonetheless, alumni members also pointed to a number of obstacles to successful technology-based interaction. Twenty respondents were aware of the lack, fifteen of the limited institutional followups, ten of the outdated databases, ten of low alumni participation and five of technical problems with portals.

Table 3: Barriers to TechnologyBased Alumni Engagement

| Barrier | Frequency (No. of Alumni) |
|-------------------------------|---------------------------|
| Lack of Awareness | 20 |
| Limited Institutional Support | 15 |
| Outdated Databases | 10 |
| Low Alumni Participation | 10 |
| Technical Issues | 5 |

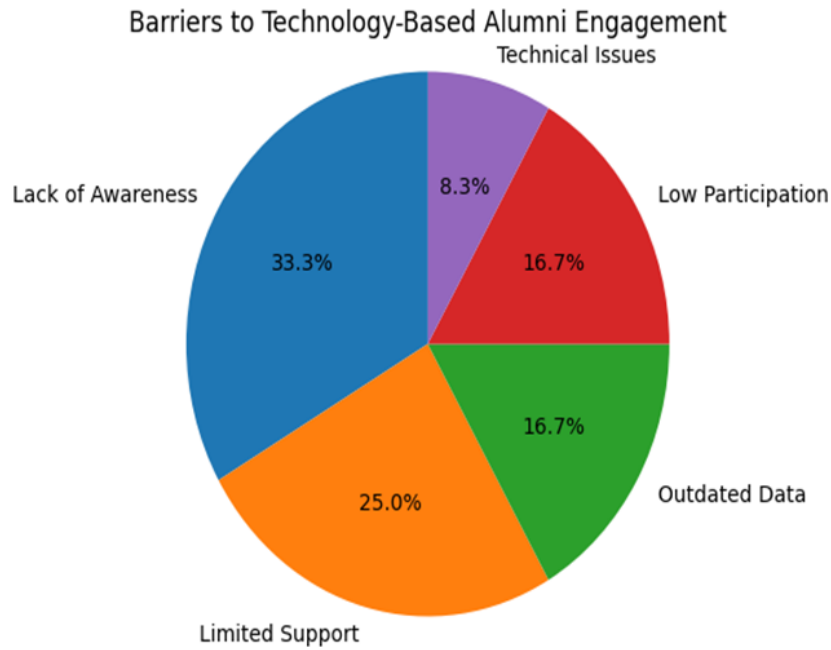


Figure 8: Barriers to TechnologyBased Alumni Engagement

This implies that although the digital infrastructure is in place, the awareness campaigns and maintenance of data are weak thus not fully used. The officials at the institutions concurred that frequent communication and updating databases are essential to maintenance of alumni networks. The general level of satisfaction with the digital engagement activity in institutions was high. Twenty of the alumni indicated that they were highly satisfied, twentyfive satisfied, ten neutral and only five dissatisfied. The discontent respondents mentioned unstable communication and the absence of individual interaction as the major issues.

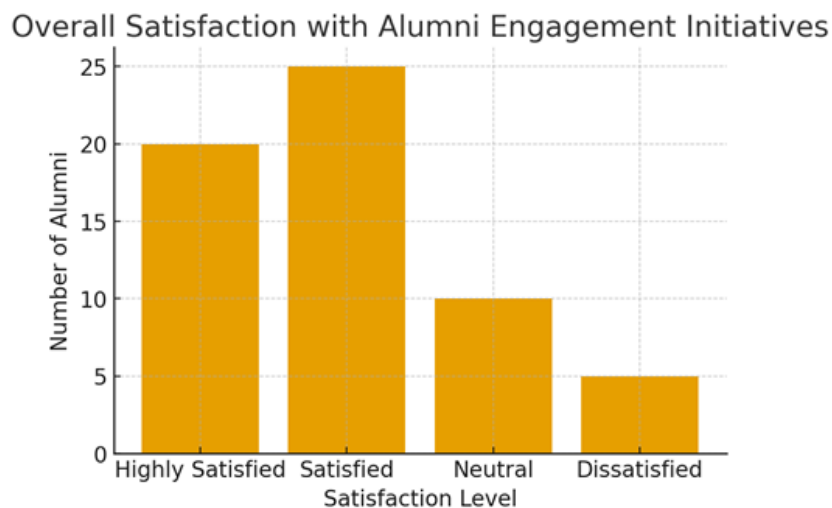


Figure 9: Overall Satisfaction with Alumni Engagement Initiatives

When it comes to future participation, half of the alumni declared their readiness to participate in future alumni programs, eight alumni were indecisive, and only 2 alumni declined to do so. This indicates that there will be a solid base on which the alumni participation can be strengthened in case the institutions increase their outreach activities.

The paper has also addressed the perception of the alumni on their influence over existing

Alumni Willingness to Participate in Future Programs

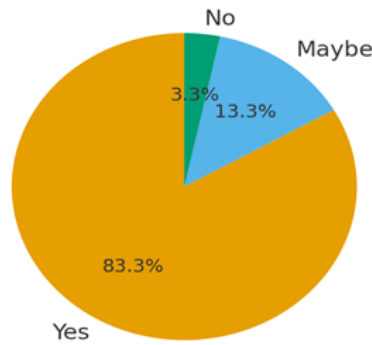


Figure 10: Alumni Willingness to Participate in Future Programs

students. More than 80 percent of the participants thought that alumni mentorships, as well as industry-related sessions, are of great importance on student exposure and employability. Alumni stressed that more organized digital mentorship programs were necessary where they would provide students with advice as to professional skills, internship placements, and research placements.

It is also observed that the level of employment is strongly associated with engagement rate employed and self-employed alumni were found to be more engaged as opposed to their high-study counterparts. The younger alumni also exhibited the higher tendency to interact through social media whereas the older alumni favored the email and formal institutional communication.

The authorities at the institution affirmed that they are collaborating to integrate various digital platforms such as the alumni portal, mobile applications, and LinkedIn communities to support the various user preferences. This internet diversification is in line with the general alumni engagement trend in the world which is hybrid in nature.

All in all, the discussion reveals that the digital transformation has transformed the alumni engagement in higher education institutions in Punjab. Most of the respondents showed enthusiasm towards the digital efforts made by their institutions particularly those that dealt with networking and mentorship. Nonetheless, improved followup, database management and personalization of outreach can be improved.

Those institutions that successfully harness the benefits of technology, have an active communication channel, and balance the alumni level of engagement with the need to carry out career development programs are bound to create a stronger and lasting relationship with their alumni. These strategies strengthen the alumni as well as the image of an institution and student achievement.

The conclusion of the analysis is that digital tools in combination with a clear policy of engagement and institutional commitment are powerful bridging tools between alumni, students, and academic institutions in a mutually beneficial ecosystem.

4.1 Chi-Square Analysis

Chi-square tests were conducted to examine relationships between demographic variables and alumni engagement in technology-mediated initiatives.

Key Findings:

- **Gender vs Participation Frequency:** No significant association was observed ($\chi^2 = 1.87, p = 0.172$), indicating similar levels of engagement between male and female alumni.

- **Age Group vs Participation Frequency:** A significant association was observed ($\chi^2 = 8.25, p = 0.016$), indicating that younger alumni (25–34 years) are more active in online events, mentoring programs, and digital networking sessions.
- **Program vs Participation Frequency:** No significant association was found ($\chi^2 = 3.12, p = 0.211$), suggesting that academic background does not strongly influence participation.
- **Frequency of Institutional Updates vs Engagement:** A significant association was identified ($\chi^2 = 10.94, p = 0.004$), highlighting the importance of regular communication in boosting alumni participation.

Table 4: Chi-Square Analysis of Demographics and Engagement

| Variable | χ^2 Value | df | p-value | Interpretation |
|--------------------------------------|----------------|----|---------|---|
| Gender vs Participation Frequency | 1.87 | 1 | 0.172 | Not significant; similar engagement across gender |
| Age Group vs Participation Frequency | 8.25 | 2 | 0.016* | Significant; younger alumni engage more |
| Program vs Participation Frequency | 3.12 | 2 | 0.211 | Not significant; engagement independent of program |
| Frequency of Updates vs Engagement | 10.94 | 2 | 0.004** | Significant; regular updates increase participation |

* $p < 0.05$, ** $p < 0.01$

Chi-square analysis was conducted to examine the relationships between demographic variables and alumni engagement in technology-mediated activities, including online events, mentoring programs, networking forums, and digital communication. The results provide nuanced insights into how institutional technology initiatives interact with alumni characteristics.

1. Gender and Participation Frequency

The analysis revealed no statistically significant association between gender and participation in alumni engagement activities ($\chi^2 = 1.87, p = 0.172$). This finding suggests that both male and female alumni engage similarly with technological platforms.

Interpretation:

- This indicates a gender-neutral adoption of technology-mediated initiatives, reflecting that digital engagement strategies appeal equally to all genders.
- From an institutional perspective, engagement campaigns do not need to be heavily gender-targeted; instead, they can focus on activity type or communication frequency.

2. Age Group and Participation Frequency

A significant association was observed between age group and engagement ($\chi^2 = 8.25, p = 0.016$), with younger alumni (25–34 years) participating more actively than older alumni.

Interpretation:

- Younger alumni are typically more technologically proficient and comfortable with digital platforms, virtual networking, and online mentoring.

- Older alumni may face challenges such as lower digital literacy or time constraints, limiting their participation.
- This finding suggests that targeted support or training may be beneficial for older alumni to enhance inclusivity.
- It also highlights a generational trend in alumni engagement: technology-mediated platforms are more effective for digitally native cohorts.
- Institutions could develop multi-channel engagement strategies: social media, webinars, and apps for younger alumni, while supplementing with emails, newsletters, or offline events for older groups.

3. Program / Stream and Participation Frequency

The association between academic program and participation was not significant ($\chi^2 = 3.12, p = 0.211$).

Interpretation:

- Alumni engagement appears to be independent of educational background, suggesting that institutional technology initiatives are universally accessible and appealing.
- This underscores the potential of technology to standardize engagement, removing program-specific barriers.
- It also allows institutions to design generalized digital engagement strategies without needing program-specific adjustments, saving resources while maintaining broad impact.

4. Frequency of Institutional Updates and Participation

A highly significant association was found between the frequency of institutional updates and engagement levels ($\chi^2 = 10.94, p = 0.004$). Alumni receiving regular updates were more likely to participate in online events, mentoring programs, and digital forums.

Interpretation:

- This emphasizes that consistent communication is a key driver of technology-mediated engagement.
- Regular updates serve multiple functions: they remind alumni of upcoming activities, highlight the benefits of participation, and reinforce the emotional connection with the alma mater.
- Institutions can leverage technology to deliver personalized notifications, leveraging email campaigns, app push notifications, or social media posts.

4.2 Correlation Analysis

Pearson correlation analysis was used to assess the relationships between technology-mediated engagement variables and alumni satisfaction.

Key Findings:

- Frequency of Updates showed strong positive correlation with overall satisfaction ($r = 0.60, p < 0.001$) and moderate correlations with emotional connection ($r = 0.48, p = 0.002$) and perceived value as an alumnus ($r = 0.46, p = 0.003$).

Table 5: Correlation Matrix of Alumni Engagement Variables

| Variables | 1 | 2 | 3 | 4 |
|-------------------------|---|--------|-------|-------|
| 1. Frequency of Updates | 1 | 0.60** | 0.48* | 0.46* |
| 2. Overall Satisfaction | | 1 | 0.50* | 0.48* |
| 3. Emotional Connection | | | 1 | 0.42* |
| 4. Perceived Value | | | | 1 |

* $p < 0.05$, ** $p < 0.01$

- Perceived Effectiveness of Digital Platforms was moderately correlated with emotional connection ($r = 0.52, p = 0.001$) and intention to remain connected with the institution ($r = 0.42, p = 0.010$).

The positive correlations suggest that consistent communication and effective digital platforms enhance alumni satisfaction, emotional connection, and perceived value. These findings underscore the importance of integrating user-friendly technology into alumni relationship management strategies. Digital platforms not only facilitate participation but also strengthen the alumni-institution bond.

4.3 Patterns of Alumni Engagement

Analysis of engagement patterns revealed the following:

- **Most Participated Activities:** Mentoring programs (43%), online networking sessions (37%), digital forums (35%).
- **Primary Motivators:** Career development (45%), professional networking (40%), emotional attachment to alma mater (35%).
- **Barriers to Participation:** Lack of time (40%), geographic distance (30%), insufficient communication (28%).

The results highlight that digital initiatives overcome traditional barriers, such as distance and scheduling conflicts. Activities focused on career development and networking are particularly effective in engaging alumni. Institutions can optimize engagement by combining timely communication with virtual events and professional development opportunities.

5 Conclusion

Finally, the research confirms that technology has emerged as a critical stimulus to changing the alumni involvement within institutions of higher learning in Punjab, which offers sustainable, accessible, and interactive mediums, which enhances communication and establishes a continuous communication process. Online platforms social media networks all the way to webinars and virtual mentorship programs have allowed institutions to go beyond geographical boundaries and find lasting relationships that go way beyond event-oriented interactions. Nevertheless, the results also highlight that not only the adoption of digital tools is insufficient; it will be essential to engage the participants in meaningful ways through regular communication, well-organized coordination, data management, and an active institutional culture that perceives alumni as long-term partners. Higher interest and closer relationships with their graduates are achieved when the institutions incorporate alumni engagement in their strategic planning, use up to date databases and provide valuedriven opportunities like skill sharing and career mentoring. The

trend is to move to ongoing, relationship-based ecosystems of engagement as alumni look more to establish themselves professionally and, at the same time, remain emotionally connected as a continuing trait. However, in the end institutions which integrate technology, administrative support, and a culture of inclusiveness in a strategic manner will be in the best position to instill loyalty, boost the development of students, build a stronger institutional brand and be able to survive in the contemporary educational environment.

6 Declarations

Funding

This research received no external funding.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Ethical Considerations

The authors state that all work related to this research was conducted in accordance with institutional, national, and international guidelines and in compliance with recognized ethical standards. Informed consent was obtained from all individual participants included in the study.

AI Usage Statement

No generative AI tools were used in the preparation of this manuscript.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Code Availability Statement

The software codes used in this study are available from the corresponding author upon reasonable request.

SDG Alignment

This research is aligned with the following United Nations Sustainable Development Goals (SDGs):

SDG 4 – Quality Education;

SDG 16 – Peace, Justice & Strong Institutions;

SDG 17 – Partnerships for the Goals.

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