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### From Green Intentions to Golden Returns: The role of Innovation in achieving Sustainability Performance

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<p><b>Mr. Asif Raza</b> Air University School of Management Sciences, Air University Islamabad, Multan Campus Email: <a href="mailto:khattak124scr@gmail.com">khattak124scr@gmail.com</a></p> <p><b>Moin Ahmad Moon*</b> Air University School of Management Sciences, Air University Islamabad, Multan Campus Email: <a href="mailto:moin@aumc.edu.pk">moin@aumc.edu.pk</a></p> <p><b>Allah Ditta</b> Department of Business Administration, Air University Islamabad, Multan Campus Email: <a href="mailto:adm@aumc.edu.pk">adm@aumc.edu.pk</a></p>	<p><b>Abstract</b></p> <p>This paper assesses the importance of financial resources and Intellectual Capital in SMEs' environmental and financial performance with the mediating role of technology innovation. Through a survey, 157 owners and managers of Pakistani SMEs provided empirical data for the models testing. The structural equation modeling results demonstrate that financial resources and intellectual capital have a significant positive Influence on environmental, financial performance, and technology innovation. Additionally, the outcome showed that technology innovation mediates to some extent the relationships between financial resources and the financial and environmental performance of businesses. In a similar vein, technology innovation fully mediates the link between intellectual capital and financial performance but only partially mediates the relationship between government intellectual capital and environmental performance. According to this research, the government and policymakers should give the industrial sector financial resources to boost technological innovation and performance. This will enable these businesses to support economic and environmental progress.</p>
<p><b>Keywords:</b></p>	<p>Intellectual capital, Financial Resources, Technology Innovation, Financial Performance, Environmental Performance.</p>

### Introduction

Conventionally, private firms were engaged in improving financial performance to endeavor and secure a required position in the market. Conversely, in the current era, along with financial performance, there has been emergent need and prominence of environmental performance that can ominously enhance performance and Competitive position (Khan, Anwar, Li, & Khattak, 2020; Memon, Yang, Memon, 2019). To emerge the organizational traditional and financial related activities change into voluntary based activities and innovation the trend starts because of an uncertain market condition, globalization and environmental pressure (Memon, Yang, Memon, 2020). Anyhow, enterprises regardless of their nature and size pay attention to more than just financial performance, although these persistent engaged in improving environmental performance and innovation (e.g., Anwar & Li, 2020; Mansoor, Jahan, & Riaz, 2021).

Small and medium-sized businesses (SMEs) specifically encounter significant difficulties when it comes to environmental initiatives and a lack of funding. They are unable to implement and achieve sustainable and environmental practices due to a lack of human capital and creativity (Ogbeibu et al., 2020; Khan & Abasyn, 2017). For instance, Li et al. (2020) found that one of the biggest issues facing SMEs nowadays is sustainability. As to the recent report, in Pakistan, 95% of SME's are operating, and 40% do a part in the country's GDP out of 3.2 million (Khan, Yang & waheed, 2019. More than half of newly started business failed in the starting stages in all over the world due to well-known things: lack of financial resources, lack of intellectual capital and also lack of technological innovation (Khattak Khattak & Shah, 2020). A plethora of research work has been done to unleash the factors such as networking (Anwar, Rehman & Shah, 2018). Knowledge sharing (SotoAcosta, Popa & Marqués, 2017), IT capabilities (Neirotti & Raguseo, 2017), creativity (Sussan et al., 2017), entrepreneurial orientation (Irwin et al., 2018) etc that influence environmental and financial performance (Latan et al., 2018; Miroshnychenko, Barontini, & Testa, 2017).

Enterprises require various tangible financial resources and intellectual capabilities to boost their operational activities (i-e., Khan, Anwar, Li, & Khattak, 2020; Khattak and Shah, 2020). Correspondingly, firms can encourage IT managers to improve the technological process (i-e., Najafi-Tavani et al., 2018) and vice versa. Financial resources, however, are necessary at every level that can either directly or indirectly improve business success. Additionally, this study examines the role that financial resources and intellectual capital play in technological innovation that affects both financial and environmental performance. Stated differently, the uniqueness of this study is in evaluating the contribution of financial resources, intellectual capital, and technological innovation. SMEs are unable to improve their performance because they lack resources and support (Khattak and Shah, 2020). According to Fernando, Jabbour, and Wah (2019), organizations might invest in new technology to achieve innovative activities and inventive performances; hence, financial resources and intellectual capital have become important predictors in this perspective.). This study is going to contribute in the existing body of literature by investigating the mediating role of technology innovation.

This study supports the RBV theory (Barney, 1991), which views technological innovation as a material resource that can provide a company with improved performance and a long-term competitive advantage (Chege, Wang & Suntu, 2020). According to RBV theory, a company can achieve high performance through environmental-based operations (Khan, Yang, & Waheed, 2019). However, there are little factual arguments about RBV in terms of the environment, particularly in the SMEs sector (Álvarez Etxeberria, Ortas & Gallego-Alvarez 2015). Recent studies suggest that interactive and technology-driven environments significantly influence behavioral outcomes and organizational performance, highlighting the strategic importance of innovation in contemporary markets (Moon, 2026).

On the other hand, our study concentrated on financial resources, intellectual capital, and technological innovation as important tangible and intangible resources for excellent financial and environmental performance that are seldom covered from an RBV perspective.. This study examines the neglected zone of research to investigate how financial resources and intellectual capital can enhance the financial and environmental performance through technology innovation in emerging economies. Our study assisted SMEs' owners and top managers in allocating sufficient funds to advance their technological innovation. The Practical implication of this study for owners and managers is that to get a better financial and environmental performance an organization must have improved their skills and knowledge about technology innovation and implement it so raise the profits. It will be helpful for different stakeholder like business manager, regulators, policy makers and government to take corrective actions that the SMEs firms can accomplish/ achieve high growth and environmental stability.

### 1. Literature review

Stewart (2010), intellectual capital is the body of knowledge, experience, and skill that individuals and organizations possess that allows them to outperform competitors. According to Farhadi et al. (2009) and Liu (2017), Relational, structural, organizational, social, consumer, and human capital are only a few of the different facets of intellectual capital. However, the majority of research favors the three essential characteristics of customer capital, human capital, and relational capital. However, one of the

most crucial business operations that affects an organization's internal procedures and reporting systems in a way that is consistent with cost-effectiveness is intellectual capital (Sharma 2017b and De Villiers). Intellectual capital is regarded by the enterprises' RBV as a critical component in giving them a competitive edge. Intellectual capital is seen to be extremely important for businesses since it can affect both the company's non-financial and financial performance. According to De Villiers and Sharma (2017a, 2017b), the first step involves the impact of intellectual capital on the firm's internal procedures and financial reporting system, which are linked to the profitability and competitiveness of businesses. The RBV theory states that one of a company's most important intangible assets that boosts its competitiveness in comparison to its competitors is intellectual capital (Barney 1991). According to Sharabati et al. (2010a) and Sharabati et al. (2010b), ventures in a competitive environment face intense competition and external pressures. In response, they develop intellectual capital in the form of human capital, structural capital, and relational capital, which enable the integration of other resources to give the firms a competitive advantage over their competitors. Intellectual capital is crucial for businesses to attain and preserve sustainability in the present competitive business environment when every company is vying for limited resources. The majority of organisations invest in sustainable practices in order to convey a positive message to the public and stakeholders. It can also assist them in achieving their financial and social goals. (Smith, Golicic and 2013; Podsakoff et al. 1997). However, SMEs struggle with resource scarcity, which makes it difficult for them to engage in eco-friendly activities (Khattak 2020; Wang 2020 and Chege). As a result, the majority of SMEs chose to use intellectual capital, which is less expensive and requires less investment, to implement environmental and sustainable practices Khan et al. (2019b). According to Tonial et al. (2019), for example, intellectual capital management greatly promotes sustainable practices. For example, Tonial et al. (2019) contended that sustainability practices are greatly facilitated by intellectual capital management. Along similar lines, Yong et al. (2019) concluded that there was a strong correlation between environmental sustainability and sustainability practices with all components of green intellectual capital. They went on to say that businesses should emphasize the value of green intellectual capital since it gives them a sustainable competitive edge and enables them to meet environmental goals as part of corporate social responsibility (CSR) initiatives, which are a major factor in determining a company's financial performance. Sustainability-related initiatives can shape stakeholder perceptions and strengthen organizational relationships when supported by credible and responsible business practices (Moon et al., 2026). As such, the concept of intellectual capital has been considered as one of the most promising solutions for SMEs to enhance their financial and environmental performance (G. Li et al. 2020, Jardon and Dasilva 2017 ;). In light of the resource base view theory and these factors, we put out the following initial hypothesis:

**H1:** Intellectual capital significantly affects the financial performance.

**H2:** Intellectual capital significantly affects the environmental performance.

### **2.1 Financial resources, environmental and financial performance**

Financial resources are crucial for green and environmental efforts in addition to IC (Marín-Vinuesa et al. 2020; Memon et al. 2020). Enough funding is required for eco-friendly and green management techniques. Lack of funding prevents ventures from carrying out green management initiatives (Ruggiero and Cupertino 2018). Businesses use remanufacturing and green methods while weighing the costs and benefits (Peng et al. 2020; Xu et al. 2020). Furthermore, due to their limited financial resources, the majority of SMEs are reportedly reluctant to adopt and participate in GSCM operations (Tong et al. 2020). It makes clear that funding is essential for green and environmental projects. Businesses must have enough financial resources and strength to gain high performance in green activities and environmental (Artiach et al. 2010). Studies such as Cormier and Magnan (1999) and Clarkson et al. (2011) empirically established that the financial conditions of a firm have a significant relationship between CSR involvement and green practices. Given the long-term benefits of these management approaches, it motivates managers to support and engage in green initiatives. Intellectually capable managers are more inclined to engage in environmentally friendly actions. However, having sufficient financial resources encourages them to engage in green and environmental initiatives (Milgrom 2002; Reverte 2009). In the case of SMEs, it is indeed logical that intellectual capital improves green activities but mere intellectual capital is not sufficient. For managers to carry out green practices successfully, they require sufficient funding. (Jan et al. 2019; Hasan and Habib 2017). Financial sufficiency is the key to environmental activities, and managers use their competences and talents to lower various social and environmental costs (Venieris et al. 2015). In conclusion, we argue that although the elements of intellectual capital are crucial for GSCM practices, financial resources are actually needed to establish the partnership and successfully implement green initiatives. Technological capabilities and service quality have become increasingly important drivers of organizational effectiveness and customer value creation in modern business environments (Tariq et al., 2026). Additionally, we anticipate that companies with strong financial standing will be more inclined than those with poor financial standing to engage in and profit from green management initiatives. Therefore, we hypothesize as follows

**H3:** Financial resources have a significant on financial performance.

**H4:** Financial resources have a significant on environmental performance.

### 2.2 Intellectual Capital and Environmental Performance

A plethora of research has termed intangible assets in particular the intellectual capital as the key determinant of competitive advantage (Segelod, 1998). Klein and Prusak (1994) define the intellectual capital as a package of useful information which can be captured, formalized and leveraged in order to produce a valued asset. Similarly, Stewart (2010) termed intellectual capital as a cluster of knowledge, information and experience which individuals and institutions possess that provides a competitive edge to firms over their competitors. Whereas Hall (1992) distinguished intellectual capital as an asset and intellectual capital as a skillfulness. Stewart (1997) recognized practical experience, knowledge gained, organizational techniques, customer relationship and professional skills as skilled intellectual capital. Because of its significance, scholars have recognized several aspects of intellectual capital, including, organizational, customer, human, social, relational and operational capital (Farhadi et al., 2019; Liu, 2017). Nevertheless, intellectual capital remains the pivotal element for enterprises due to its crucial influence over the internal processes and systems of enterprises which are closely associated to the cost effectiveness (De Villiers and Sharma, 2017 b). In fact, the RBV perspective also supports the argument that the firms' intellectual capital is the key determinant of enterprise's competitive advantage over its rivals.

RBV perspective suggests that the firms are being characterized by their unique resource base (Marr, Grey and Neelay, 2003), and the role of intellectual capital in this resource base is growing (Marr et al., 2003). Therefore, for superior performance, it is obligatory for firms to identify, develop and utilize intellectual capital in more efficient manner. Keeping in view the importance of IC, abundance of research papers has investigated the role of intellectual capital in diverse industries (like, pharmaceutical/chemical, service, banking/finance, manufacturing, etc.) and countries (like, USA, Australia, UK, Pakistan, Malaysia, Greece, etc.)

Empirical evidence suggests that the firm's intellectual capital has significant influence not only over the firm's financial performance but also non-financial performances. First, a company's internal systems and procedures are shaped by its intellectual capital and are directly linked to its competitiveness and profitability (De Villiers & Sharma, 2017a, 2017b). According to RBV theory, intellectual capital gives a company a competitive advantage over its rivals, making it one of the most essential intangible resources (Barney, 1991). Due to limited resources, business firms heavily rely on intellectual capital to achieve and sustain sustainability in this competitive climate. In order to provide a positive image of the company to stakeholders and the public, the majority of businesses invest their resources in sustainability practices. Additionally, this helps enterprises achieve their social and financial goals (Golicic & Smith, 2013). However, SMEs' participation in eco-friendly activities is hindered by a shortage of resources (Cheg & Wang, 2020; Khattak, 2020). Since intellectual capital is thought to be less expensive than other company resources, the majority of SMEs use it to adhere to environmental and sustainable standards (Khan, Yang, Waheed, 2019). Hence, number of researchers have diverted their attention towards green intellectual capital. Chen (2008) incorporates environmental concepts into intellectual capital in order to fulfil the previous deficiencies.

Green intellectual capital empowers firms to comply with the international environmental regulations. Nevertheless, multiple studies have reported a positive nexus between intellectual capital and firm's environmental performance. For instance, Huang and Kung (2012) argued that the firm's intellectual capital is associated to its environmental performance. They suggested that because environmental management includes both tacit and explicit knowledge (see, Boiral, 2002) therefore intellectual capital plays important role in such firm's which are more anxious towards sustainability with the help of transferring knowledge linked to the environmental regulations' technologies, initiatives and practices in order to fulfill the sustainability goals. In Similar vein, Yong, Ramayah Yusliza, and Fawehinmi (2019) found that all dimensions of green intellectual capital significantly influence the environmental sustainability and its practices. They further argued that the firm's must encompass green intellectual capital because it fulfills their environmental goals as a part of CSR and also provides them competitive advantage. Consumer decision-making is often influenced by psychological and behavioral factors, emphasizing the importance of understanding intangible drivers of organizational outcomes (Farooq & Moon, 2025a). To analysis, intellectual capital is adopted as one of the finest strategies for elevating the financial and environmental performances in SMEs (Dasilva, 2017; Li et al., 2020 Jordon). Hence, drawing on the discussion from the perspective of RBV theory, study hypothesized that:

**H5:** *Intellectual Capital is significantly related to the environmental performance of SMEs.*

### 2.3 Financial Resources and Environmental Performance

It is evident from the above discussion that the managers with adequate intellectual capital do outscore in their firm's environmental performance, however, the intellectual capital alone may not be enough to improve the environmental performance (Khan, Anwar, Li & Khattak, 2021). In fact, the willingness of an enterprise to indulge in environmentally friendly practices is largely derived from the availability of financial resources. Hence, it is rational to suggest that along with IC, financial resources are also

important for firms to spur environmental and green practices (Marin- Vinesa, Scarpellini, Portillo-Tarragona & Moneva, 2020). A company that wants to improve its environmental performance would, in general, set targets to lessen its influence on the environment by creating goods, technologies, and processes that are more sustainable and less polluting (Kemp & Pearson, 2007; Kemp & Pontoglio, 2011).

The literature (see, for example, Marzucchi & Montresor, 2017; Scarpellini, Marín-Vinuesa, Portillo-Tarragona, & Moneva, 2018) provides a thorough explanation of the importance of a company's financial resources in relation to environmental performance. Therefore, adequate funding is required for eco-friendly activities. On the other hand, businesses with less funding don't use green management practices (Ruggiero and Cupertino 2018). Hence, sufficient finances are necessary for environmentally friendly practices. Whereas ventures with limited finances fails to comply with the green management activities (Ruggiero and Cupertino 2018). Furthermore, such firm's use cost and benefit analysis while indulging in green and environmental practices (Peng, Wang & Xu, 2020; Xu, Shi & Chen, 2020). According to Machiba (2010), green activities typically take several forms and take place at various levels and scales in response to environmentally friendly methods that demand financial investment. In this context, Demirel et al. (2017) contended that the degree of risk associated with such investments prevents enterprises from engaging in eco-innovative processes because of their limited financial resources. Furthermore, Ayyagari et al. (2007) contend that while enterprises with little financial resources are discouraged from adopting innovative tactics, those with increased financial resources are more likely to adopt new technology along with products and strategies (Pellegrino & Savona, 2017). Hence, it is evident that the poor financial situation restricts SMEs from adopting and participating in GSCM activities because of the lack of financial resources. Thus, financial resources are crucial for environmental and green initiatives. SMEs requires sufficient capital and determination to improve the environmental performance (Artiach et al., 2010). Researchers such as Clarkson et al., (2011) and Comeir and Magnan (1999) empirically proved that the firm's noble activities like CSR and green practices are derived through the stable financial conditions. With adequate financial resources, the managers/owners are encouraged to promote the green activities due to its long-term benefits. SMEs are therefore encouraged to engage in green and environmental activities when they have a high level of intellectual capital and adequate financial resources (Reverte, 2009). Prior research highlights the role of motivational factors in shaping behavioral intentions and market-related outcomes across different contexts (Farooq & Moon, 2025b). In summary, the current study makes the case that having adequate financial resources is essential to setting up eco-friendly operations that improve businesses' environmental performance. Thus, our hypothesis is that:

**H6:** *Financial resources has significant positive impact over the environmental performance of SMEs*

### **2.4 Technological innovation and firm performance**

Researches showed that there is a significant relationship among the technological innovation and the firm's financial performance. (Katsaros, Tsirikas, & Kosta 2020). Similarly, Khorshid, and Mehdiabadi, (2020) argued that introducing a unique and valuable products in the routine significantly contribute financial performance, which leads to risky contributions (Chernev, A. 2020). In this way, managers' priority is to limit the trend of technological innovation (Di Vaio, & Varriale 2020), especially in firms (Ted and Besant 2013). According to Chesborough (2010), through their business models, firms exchange new ideas and technologies. To modernize their business model with little ability, they require a broad contribution and practice. Hence, complications in managing innovation can prevent firms from efficiently creating value through their innovation struggles. Such as, even though some studies have revealed a significant relationship between innovation and performance of the firm (Cigoj, 2020) found no correlation between innovation and financial performance.

In some cases, contamination would be proof of misuse of assets that impact the firm's profitability (Gritsenko, D., & Efimova, E. 2020). Unique telecommunication can be considered to resolve financial difficulties through reducing the impact of pollution (Stone, T., F. S., de Sio & Vermaas, P. E. 2020) Technology modernization is expected to generate double profits: play a role in technological innovation of the economy while limiting the environmental burden (Liu, Zhu, J., Li, Meng, & Song 2020), technological innovation must meet certain criteria in order to work efficiently: firstly, it should be placed on unique technical information, secondly, this should even now be in field. For example unique commodities may already have been placed into the wholesale and unique procedures that are already enforced inside the company.

It is mainly approved that innovation makes firm's performance better by growing productivity, lowering the expenses or establishing unique marketplace (Rodríguez, R., Molina-Castillo, & Svensson, 2020), along proficiency generally also affected from the volume of the firm. (Broothaerts, Cordeiro, Corbisier, Robouch, P. 2020) and structure of the market Geroski, 1990). Numerous studies have examined the connection between environmental performance, environmental management, and financial performance in sustainable businesses (Ali, Sial, Brugni, Hwang, Khuong, & Khanh. 2020). Furthermore, in a context of company, stability is seen as a chance to make better Competition. (Tan, Lau, M., & Gozgor 2020).

Intellectual capital can be considered as a valuable asset that is not expressly listed on a balance sheets of the firm, but positively affects its performance, thus reveal the relationship between workers, ideas and data and measures what is not measured (Edvinsson, 1997).

It is an ordinary knowledge that balance sheets do not attempt to give data about the real value of a firm. Hence it's concluded that technological development contingent on financial resources and firms required to continue its operation with latest technology by efficiently utilize their current financial resources (Yoonkyo Cho, 2020).

Their results demonstrate by financial resources become a vibrant factor for technology innovativeness (Cahill, Baur, Liu, & Yang, 2020). Trust and digital engagement mechanisms have been identified as important factors that contribute to stronger organizational performance and stakeholder relationships (Moon et al., 2025).

The importance of the money related assets for natural Research and development and environmental advancement done for likewise s examined (Kularatne, Wilson, Månsson. Hoang, & Lee, 2019) as well as previous innovative capability of companies (C. H., & Huang, Chen, Q., Wang, S. Z. (2020) and human resources (Kassymova, et al 2019).

*H7: Technology innovation mediates the relationship between financial resources and environmental performance.*

In the light of the rise of the "information-based economy" and its accentuation after putting resources into information based resources, numerous researchers and business built up a relating interest for the ideas of intellectual capital. Therefore, various earlier inquiries have concentrated on creating hypothetical models that address how to adequately manage Technology advancement through intelctual capital, just as inspecting how different parts of intellectual capital encourage the proper circumstances for the item or procedure development to create (Al Hashmi, Azam, S. F., & Khatibi, A.2020).

Creating and keeping up long haul associations with key partners, especially clients are urgent to protecting the aggregated information basis on capital applicable and helpful. The inevitable result of these "scholarly capital development" endeavors is upgraded and supported Technology Innovation, on the grounds that managing Technology advancement is essentially viewed as information basis and helpless procedures (Rafi, M., JianMing, Z., & Ahmad, K. 2020).Financial decision-making behavior continues to play a significant role in determining both individual and organizational outcomes in evolving economic environments (Asjad et al., 2025).

Results exhibit that innovation development methodology influences all Intellectual Capital segments, the inner auxiliary capital backings the social and human capital, and the last two influence firm innovation advancement execution (Maria Crema & Chiara Verbano 2015).

### 1.1 2.5 Financial resources and financial performance

The findings demonstrate that a firm's worth and benefit are significantly impacted by each of the three invincible resources. It's interesting to note that this research indicates that publicity contributions have the biggest impression on the firm's value and benefit. This paper makes an assumptions about how SMEs will achieve their advantages and worth. The study's findings demonstrate that immovable contributions are not a surplus of money for SMEs and that these three crucial partners human capital, advertising, and R&D with the business management approach can invest in and use immovable assets strategically to meet their management goals (Young Jun Kim, Hyeon Sik SEO, 2019)

According to Chowdhury et al. (2014), human capital is a special and advantageous resource that empowers a company to manage its competitive advantage. It is made up of skills and intuition that employees acquire through training and experience. It plays a significant role in the company's learning potential. (Leonard-Barton, 1992; Yam et al., 2004; Coff, 2002; Chen & Huang, 2009) Human capital resources, including learning, practice, and know-how, are thought to be crucial to the firm's competitiveness and worthy (Barney, 1991; Saridakis et al., 2017). Strategic communication and marketing activities can influence stakeholder responses and contribute to organizational competitiveness and performance (Tassen et al., 2025).

Numerous growing firms are contributing in natural modernization as their organizers determine policies chances over environmental modernization, and its ability to deliver long lasting benefits rather than costs that are irreparable. (Shwom, R., & Kopp, 2019). Additionally, firms which develop green technologies can take benefit from the present movement towards favorable environment formulation and attract governance to additional tough rules, increase the cost of production for their competitors, and concurrently they can fascinate consumers and upgrade the position (Chetty, T. 2019). Our findings indicate the purpose of distinct economic resources for environmental innovation and related findings to show in-depth knowledge of environmental innovation and the process of decision making related to other attributes of environmental companies owned by Green copyright (Kobarg et al., 2020).

*H8: High financial performance is enjoyed by firms with substantial financial resources.*



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### 2.6 Technology innovation and Environmental performance

Enhancing technological environmental innovation is essential to boost continual advancement, as the practice of environmental innovation has a significant positive affect on performance including economic and environmental. Improving the process of production of technological innovation is also important as it has a positive effect on economic as well as environmental performance. In order to enhance technology innovation intent and behavior, it is important to raise awareness about technological behavior through technology innovation and practice, and environmental behavior of employees and CEOs Using social media advertising to emphasize the value of environmental management is also essential. For the company's staff, environmental education is a crucial duty. More environmentalists must be developed within the companies in order to improve the attitude toward environmental behavior and subjective environmental norms. Government environmental laws must be strengthened, environmental standards must be raised, and environmental regulations must be enforced in order to develop environmental control expertise. Fines must be increased if businesses violate environmental safety regulations. Adopting green financing is crucial for companies. Businesses will receive less or no bank credit if they contaminate more, which will lower their green score. [Xingle and others, 2017]. The results show that conformity with rules of eco is the powerful forecaster of the ideal. Attention of merchandise and the electronics use has been accepted as a driver which positively affects the performance of environment. (Yudi Fernando, Wen Xin Wah 2017).

An eco-management system (EMS) would be given like a visible property which helps the firm to achieve a favorable utilization of eco-innovation. Eco-management system perform an important character in the procedure of environment or environmental goods modernization (Hazarika, N., & Zhang, X.2019).An Environmental management system is necessary as it can handle insufficient data inside an organization, Specifically when it comes to introducing price-saving cleanser electronics.(Piyathanavong et al., 2019). An Environmental management system works as an instrument to identify a lack of data in the eco-programs of the organization when companies have difficulty in re organizing probable cost savings for environmental innovation, like energy savings and material.

To raise the environmental performance environmental innovation can be used as a platform. As a result of environmental innovation, companies will reduce the amount of solid / liquid waste produced and greenhouse gas emissions. To increase environmental efficiency, firms need to familiar of the interest of their character in unattainability. The firm can suffer in the green corporation if it favorably perform an environmental-modernization policy in its environment. Particularly, when a firm achieves low production costs while protecting the environment, it will receive financial benefits (Yudi Fernando, Wen Xin Wah 2017).

We believe that environmental innovation techniques affect environmental performance more than economic performance. Particularly for Korean-owned businesses in Jiangsu, innovation in the production process has a favorable effect on environmental performance. Additionally, we are aware that Sino-Korean joint ventures are less adapted to environmental innovation than fully Korean-owned companies (WKOs). Encouraging environmental innovation in Korean-owned businesses is crucial in China. Enhancing Jiangsu's production process should be the main goal of environmental innovation (Xingle Longa et al., 2017). Organizational trust and relationship-building mechanisms are increasingly recognized as critical factors for achieving sustainable competitive advantage (Moon et al., 2024).

We have also suggest that the concurrent implementation of product innovation and process innovation is an unconditional alternative and the combined implementation of innovation and non-technical innovation is a viable alternative.

*H9: Technology innovation has positively related to environmental performance.*

### 2.7 Technology Innovation and Financial Performance

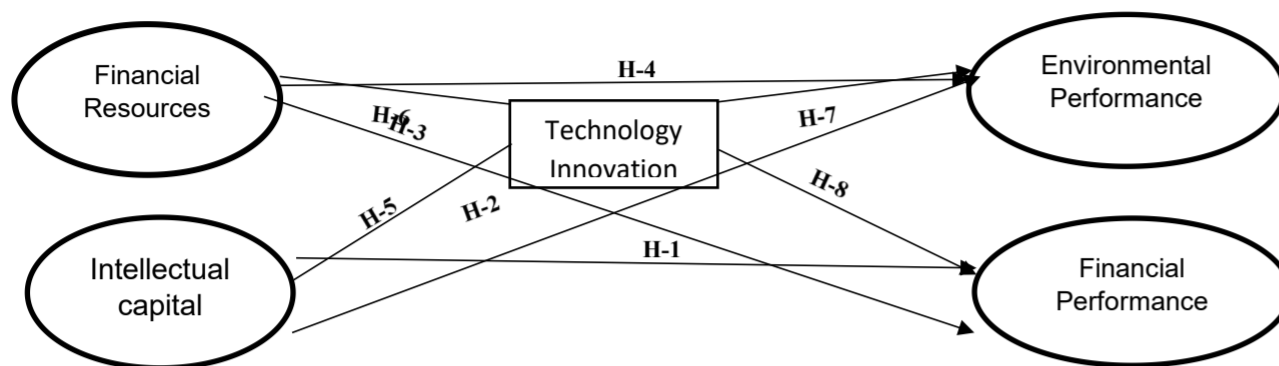
*H10: Technology innovation significantly mediate the nexus between financial resources and financial performance.*

*H10: Technology innovation significantly mediate the nexus between financial resources and environmental performance.*

*H10: Technology innovation significantly mediate the nexus between intellectual capital and financial performance.*

*H10: Technology innovation significantly mediate the nexus between intellectual capital and environmental performance.*

### Theoretical Framework



### 3 Methodology

This study's objective was to understand how technology mediates the relationship between financial resources, intellectual capital, and financial performance using a cross-sectional and quantitative research approach. Set of data is collected from those registered SME's which are located in Islamabad and Rawalpindi. The registered list of firm are collected from Islamabad chamber of commerce and Rawalpindi chamber of commerce which include trading manufacturing and service firms. Register firm in Islamabad chamber of commerce are 4500 while registered firms in Rawalpindi chamber of commerce are 5000. We put sampling formula by which we obtain 157 sample size. As per our request most of the questionnaire are filled by managers and owners because they are more connected with the organization strategies and policies. Self-administrative questionnaires were utilized to gather primary data for the study. Compared to other instruments, questionnaires are a quick way to collect data. Total distributed self-administrative questionnaires are 400, out of which 157 are received back. The response rate of received questionnaires is 39.25%.

#### 3.1 Measurements of variables

In this sub-section, the dependent variable, independent variables, as well as mediator variables are discussed and measured with the reliable scales.

##### 3.1.1 Independent variable (Financial Resources and Intellectual Capital)

The independent variable is Financial Resources and Intellectual capital. To measure Financial Resources, I ask owners and general managers to rate the competency of the firm. Financial Resources, concentrating on business operations, competitors' operations and internationalization process. Financial Resources uses a six-item, five-point Likert scale, with 1 denoting "strongly disagree," 2 denoting "disagree," 3 denoting "neutral," and 4 denoting "agree." 5 = "strongly agree,"

While the firm's goals and knowledge are the focus of intellectual capital. Six items on a five-point Likert scale are used to measure intellectual capital; 1 represents "strongly disagree," 2 represents "disagree," 3 represents "neutral," and 4 represents "agree." 5 = "Very much agree."

##### 3.1.2 Dependent variables

The financial and environmental performance of the company are the dependent variables. Engelen et al. (2015) and Semrau et al. (2016) used five items to measure financial performance. Owners and managers were asked to evaluate the company's success during the previous three years based on ROA, ROE, and growth. A 5-likert scale was used, with 1 denoting "extremely decline," 2 denoting "decline," 3 denoting "neutral," 4 denoting "improves," and 5 denoting "extremely improved."

On the other hand, five items are used to quantify environmental performance. A Likert scale with 1 representing "extremely decline," 2 representing "decline," 3 representing "neutral," 4 representing "improves," and 5 representing "extremely improved" was provided.

##### 3.1.3 Mediating (Technology Innovation)

**Innovation in technology is the mediating variable. It contains new information and procedures. The technological innovation was measured using five items. A 5-Likert scale was employed, with 1 denoting "strongly disagree," 2 disagree, 3 neutral, 4 agree and 5 is "Strongly Agree."**

#### 3.2 Data analysis, results interpretations, & Discussion

##### 3.2.1 Profile of the firm

We discover that 25.5% of the firms have between 10 and 50 employees, 50.3% have between 51 and 100 employees, and 24.2% have between 101 and 250 employees. According to the study, 21.7% of enterprises have been in operation for less than ten years, 49.0% have been in operation for eleven to twenty years, and just 29.3% have

been in operation for more than twenty-one years. The analysis shows that the manufacturing sector accounts for 36.9%, the trading sector for 43.3%, and the services sector for 19.7%. According to Table 1,

**Table: 1 Demographic of the SMEs participants**

Description	Number of Org	%
Size of the Org		
• 10-50 participants	38	25.52
• 51-100 participants	80	50.34
• 101-250 participants	39	24.23
Age of Corporation		
• Upto or Less than 10 years	35	21.71
• Between 11 to 20 years	75	49.03
• More than 20 years	47	29.31
Name of company		
• Industrial Org	57	36.90
• Trading Org	70	43.34
• Services Org	30	19.71

### 3.2.2 Reliability Test

The internal consistency of the variable items in this study was assessed using a reliability (consistency) test. Cronbach's Alpha was utilized to assess the internal consistency of the gathered data. In order for the overall variable to be greater than 0.70 as advised, the study's results are displayed in Table 2. A reliability value of more than 0.70 is regarded as good and reflects internal consistency (Nunn ally & Bernstein, 1994).

**Table: 2 Reliability Test**

Variables	No of items	Cronbach's alpha
Intellectual capital	6	.71
Financial Resources	6	.84
Environmental Performance	5	.85
Financial Performance	6	.72
Technology Innovation	5	.82

The percentage sum is not 100% accurate due to rounding.

### 3.3 Normality

The appropriateness of information for a specific variable is essentially discussed by normality. Skewness and Kurtosis, Shapiro and Walk, Shape, and other tests are frequently used in SPSS to assess the normalcy of data. However, skewness and kurtosis are typically used to assess normality (Dai, 2014; Akhtar, 2015). As a result, skewness and kurtosis were used in the current analysis to determine normality.

Information is considered skewed when respondents do not fit into the normal distribution and are weighted toward one end of the scale.. Information is certain or positive (right) if the skewness value is greater than 1, but it is negative (left) skewed if the value is less than 1.

Kurtosis is a measure of the exceptions to the distribution of data; the more anomalies there are, the higher the kurtosis.

*Skewness and kurtosis* are shown in the table below, where skewness values for Financial performance (-.266), Environmental performance (-.380), Financial Resources (.096), Intellectual capital (.916), and Technology innovation (.074). Kurtosis value for FP is (1.887), ENP (1.912), FR (0.327), IC (-0.248), and TINV (-1.043).

The table below displays the means and standard deviation for FP (3.8503), ENP (3.8408), FR (3.7887), IC (3.9087), and TINV (3.9261). The standard deviation of TINV (.25947), IC (.23528), FR (.35071), ENP (.33262), and FP (.25888).

**Table 3 Normality**

Variable	N	Min	Max	Mean	Std. Dev	Skewness	Kurtosis
FP	157	3.00	4.83	3.8503	.25888	-.266	1.887
ENP	157	3.00	5.00	3.8408	.33262	-.380	1.912
FR	157	3.00	5.00	3.7887	.35071	.096	0.327
IC	157	3.00	5.00	3.9087	.23528	.916	-0.248
TINV	157	3.20	5.00	3.9261	.25947	.074	-1.043

### 3.3.1 Correlation coefficient

Correlation coefficients show how variables are related to one another. All of the variables are connected with one another, according to the correlation results. The outcome is shown in (table-3), that is, Independent variable Intellectual capital and Mediating variable Technology innovation is 0.68 or 68% correlated, while independent variable financial resources and mediating variable Technology innovation is .29 or 29% correlated. Financial success as a dependent variable and an independent variable there is a 0.43 or 43% correlation between intellectual capital and the dependent variable financial performance, as well as a 0.43 or 43% correlation between the mediating variable technology innovations.

**Table 4: Correlation coefficient**

Variable	Mean	SD	ENP	FP	IC	FR	TINV
ENP	3.8408	.33262	1				
FP	3.8503	.25888	.719**	1			
IC	3.9087	.23528	.474**	.432**	1		
FR	3.7887	.35071	.668**	.483**	.477**	1	
TINV	3.9261	.25947	.421**	.439**	.683**	.292**	1

\*\* At the 0.001 level (two-tailed), the correlation is significant.

### 3.4 Regression Analysis

In this study, regression analysis was used to find out the relationship between independent and dependent variables. The effect of independent variables (financial resources and intellectual capital) on dependent variables (financial performance and environmental performance), independent variables (financial resources and intellectual capital) on mediator variables (technology innovation), and the impact of mediating variables (technology innovation) on dependent variables (financial performance and environmental performance) are all examined using liner regression analysis. Additionally, we examine how the independent variable (financial resources) and mediating variable (technological innovation) affect the dependent variables (financial performance and environmental performance).

### 3.5 Testing Hypotheses

There are many alliances in the study's hypothesis that differ from the straightforward liner regression method. Simple linear relationships are examined using multiple regression analysis. Preacher and Hays's (2013) process macros are utilized for testing in high-ordered relationships.

#### Financial resources' effects on financial performance, with technological innovation acting as a mediator.

The table 3 shows that FR significantly influence both firm performance ( $\beta = 0.21$ ,  $t=3.80$ ) and TINV ( $\beta = 0.32$ ,  $t=4.71$ ) which strongly support H1 and H5 of the study. Similarly TINV significantly influence FVPER ( $\beta = .35$ ,  $t=6.86$ ) which support H7 of the study. To examine the mediating role of TINV between FR and FPER, PROCESS method in SPSS has been executed. The results (see table 3) shown the direct as well as indirect effects of FR on FPER were substantial ( $\beta = 0.28$ ,  $t=5.62$ ,  $p<0.053$ ), ( $\beta = 0.041$ ,  $p<0.054$ ).The result TINV play a partial mediating role in FR and FNPER nexus. It is now preferring the H9 to some extent. Furthermore the results of Sobel test ( $\beta = 0.07$ ,

$p < 0.5$ ,  $z = 2.92$ ) and method of bootstrap at 95% level of (LL=.007, UL=.173) confidence interval also indicated that the TINV partially mediates the relationship between FR and FPER. The result of R square indicates that 33% in FPER was transmitted by FR in front of TINV

**Table 1 Results of mediation (Technology Innovation as Mediator)**

<b>Direct effect</b>					
Dept: FPER, Indep: FR, Mediator: TINV					
<b>Total effect</b>	$\beta$	S.E	Prob	t	R <sup>square</sup>
Sec1: Findings TINV					
FR	0.21	0.052	000	3.80	0.85
Sec2: Findings FPER	$\beta$	S.E	Prob	t	R <sup>square</sup>
TINV	0.32	0.06	0.00	4.71	0.33
FR	0.28	0.05	0.00	5.62	
Sec3: Findings FPER	$\beta$	S.E	Prob	t	R <sup>square</sup>
FR	0.35	0.05	0.00	6.86	0.23
<b>Indirect impact</b>					
Sobel test	$\beta$	S.E	Prob	z	
FR → TINV → FPER	0.07	0.24	0.00	2.92	
<b>Bootstrapping Process</b>					
Bootstrapping	Indirect impact	LLCI @95%		ULCI @95%	
FR → TINV → FPER	.070	.007		.173	

Note: N=232, 2,000-bootstrapping sample size, LLCI = Lower Limit Confidence Interval confidence interval, ULCI=Upper Limit Confidence Interval, DEP=Dependent variable INDV= Independent variables, MEDIV=Mediating variable

### Impact of Financial resources on Environmental performance with mediating role of Technological Innovation.

The table 2 shows that FR significantly influence both firm performance ( $\beta = 0.21$ ,  $t = 3.80$ ) and TINV ( $\beta = 0.31$ ,  $t = 4.15$ ) which strongly support H2 and H6 of the study. Similarly TINV significantly influence EVPER ( $\beta = .63$ ,  $t = 11.1$ ) which support H8 of the study. The PROCESS method in SPSS has been used to investigate the mediating function of TINV between FR and EPER. The direct as well as indirect effects of FR on ENPER were significant ( $\beta = 0.56$ ,  $t = 10.0$ ,  $p < 0.051$ ) and ( $\beta = 0.04$ ,  $p < 0.051$ ), according to the results (see table 2).The finding TINV shows a partial mediation in the relationship between FR and ENPER. Therefore it's partially accepted the H7. Furthermore the result of Sobel test ( $\beta = 0.06$ ,  $p < 0.5$ ,  $z = 1.77$ ) and process of bootstrap at 95% level of (LL=.005, UL=02.76) shows that the TINV partially mediates the relationship between FR and ENPER. R square indicates that 50% in ENPER was transmitted by FR in the front of TINV.

**Table: 2 Results of mediation (Technology Innovation as Mediator)**

<b>Direct effect</b>					
Dep: ENPER, Independent: FR, Mediator: TINV					
<b>Total effect and Direct effect</b>	$\beta$	S.E	Prob	t	R <sup>square</sup>
Sec1: Outcome TINV					
FR	0.21	0.051	.001	3.80	0.85
Sec2: Outcome ENPER	$\beta$	S.E	Prob	t	R <sup>square</sup>
TINV	0.31	0.07	0.00	4.15	
FR	0.56	0.05	0.00	10.0	

Sec3: Outcome ENPER	$\beta$	<i>S.E</i>	<i>Prob</i>	<i>t</i>	
FR	0.63	0.05	0.00	11.1	0.44
<b>Indirect effect</b>					
<i>Sobel test</i>	$\beta$	<i>S.E</i>	<i>Prob</i>	<i>z</i>	
FR → TINV → ENPER	0.06	0.04	0.01	.177	
<b>Bootstrapping Process</b>					
Bootstrapping	Indirect impact	LLCI @95%		ULCI	
FR → TINV → ENPER	.068	.005		2.76	

Note: N=232, 2,000-bootstrapping sample size, LLCI = Lower Limit Confidence Interval confidence interval, ULCI=Upper Limit Confidence Interval, DEPV=Dependent variable INDV= Independent variables, MEDIV=Mediating variable

### The role of technological innovation in mediating the relationship between financial performance and intellectual capital.

Table 4 demonstrates that IC has a significant impact on TINV ( $\beta = 0.27$ ,  $t=2.55$ ) and firm performance ( $\beta = 0.75$ ,  $t=11.6$ ), which clearly supports the study's H3, H5, and H6. Similarly, TINV has a substantial impact on FPER ( $\beta = 0.47$ ,  $t = 5.96$ ), supporting the study's hypothesis 9. TINV's mediating function between IC and FPER has been investigated using the PROCESS method in SPSS. The direct as well as indirect effects of IC on FPER were significant ( $\beta = .27$ ,  $t=2.55$ ,  $p<0.051$ ) and ( $\beta = .04$ ,  $p<0.05$ ), according to the data (see table 4).As a result, TINV mediates the IC and FNPER relationship to some extent. From now on, it is partially favoring the H9. Furthermore, the TINV partially mediates the IC and FNPER nexus, according to the results of the Normal theory test ( $\beta = 0.20$ ,  $p<0.52$ ,  $z=2.68$ ) and the bootstrap approach at the 95% level of the (LL=.066, UL=.390) confidence interval. According to the R square value, 22% in FPER was transmitted by IC in the front of TINV.

**Table: 3 Results of mediation (Technology Innovation as Mediator)**

<b>Direct Effect</b>					
Dependent: FPER, Independent: IC, Mediator: TINV					
<b>Total and Direct effect</b>	$\beta$	<i>S.E</i>	<i>Prob</i>	<i>t</i>	<i>Rsquare</i>
Sec1: Result TINV					
IC	0.751	0.062	.001	11.6	0.461
Sec2: Result FPER	$\beta$	<i>S.E</i>	<i>Prob</i>	<i>t</i>	<i>Rsquare</i>
TINV	0.27	0.06	0.00	2.55	0.223
IC	0.27	0.10	0.01	2.55	
Sec3: Outcome FPER	$\beta$	<i>S.E</i>	<i>Prob</i>	<i>t</i>	<i>Rsquare</i>
IC	0.47	0.07	0.01	5.96	0.18
<b>Indirect impact</b>					
<i>Sobel test</i>	$\beta$	<i>S.E</i>	<i>Prob</i>	<i>z</i>	
IC → TINV → FPER	0.20	0.07	0.00	2.68	
<b>Bootstrapping Process</b>					
Bootstrapping	Indirect impact	LLCI @95%		ULCI	
IC → TINV → FPER	.020	.066		.390	

Note: N = 232, 2,000-bootstrapping sample size; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval; DEPV = Dependent variable; INDV = Independent variables; MEDIV = Mediating variable

### Intellectual capital's effect on environmental performance, with technological innovation acting as a mediator.

Table 1 demonstrates that IC has a significant effect on TINV ( $\beta = 0.23$ ,  $t=1.90$ ) and firm performance ( $\beta = 0.75$ ,  $t=11.65$ ), which clearly supports the study's H4 and H5, H6. In a similar vein, TINV has a substantial impact on ENPER ( $\beta = 0.99$ ,  $t=2.44$ ), supporting study hypothesis H10. In SPSS, the PROCESS technique has been used to investigate the mediating role of TINV between IC and ENPER. The direct as well as indirect effects of IC on ENPER were significant ( $\beta = 0.66$ ,  $t = 6.69$ ,  $p < 0.051$ ) and ( $\beta = 0.04$ ,  $p < 0.052$ ), according to the results (see table 1). As a result, TINV partially mediates the IC and ENPER nexus. It is now preferring the H7 to some extent. Furthermore, the TINV partially mediates the IC and ENPER nexus, based on the findings of the bootstrap method at the 95% confidence interval (LL=1.87, UL=0.69) and the Normal theory test ( $\beta = 0.172$ ,  $z=2.241$ ,  $p < 0.5$ ). The R square score indicates that IC brought 22% of ENPER to the forefront of TINV.

**Table 4 Findings on Technology Innovation's mediating role**

<b>Direct effect</b>					
Dep: ENPER, Indep: IC, Mediator: TINV					
<b>Total and Direct effect</b>	<i>B</i>	<i>S.E</i>	<i>Prob</i>	<i>T</i>	<i>Rsquare</i>
Section 1: Result TINV					
IC	0.751	0.062	.00	11.652	0.462
Sec2: Result ENPER					
TINV	$\beta$ 0.234	<i>S.E</i> 0.123	<i>Prob</i> 0.051	<i>t</i> 1.091	<i>Rsquare</i> 0.22
IC	0.492	0.132	0.000	.135	
Sec3: Result ENPER(total effect )					
IC	$\beta$ 0.662	<i>S.E</i> 0.101	<i>prob</i> 0.001	<i>t</i> 6.693	<i>Rsquare</i>
<b>Indirect impact</b>					
<i>Sobel test</i>					
IC → TINV → ENPER	$\beta$ 0.17	<i>S.E</i> 0.09	<i>Prob</i> 0.02	<i>z</i> 2.24	
<b>Bootstrapping Process</b>					
Bootstrapping	Indirect impact	LLCI @ 95%		ULCI @ 95%	
IC → TINV → ENPER	.176	1.873		0.693	

**Note:** N=232, 2,000-bootstrapping sample size; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval; DEP V = Dependent variable; INDV = Independent variables; MEDIV = Mediating variable

#### 4 Discussion

This paper examine how financial resources and intellectual capital affect the financial and environmental performance of SMEs in Pakistan, a growing country.

First, this study shows that financial resources have a good impact on the financial and environmental outcome of Pakistani SMEs. A corporate's estimation is unaffected when it uses financial resources from other companies to carry out developments. Additionally, I discovered that mechanical development that is reliant on financial resources has a good short-term impact on firm esteem but no long-term impact. Therefore, businesses must continue to grow in order to continue having an advantage and make use of their current financial resources so as to have elite (Yoonkyo Cho 2020). Creators have portrayed that at whatever point the administrator are responsibility towards such change in plans in which natural techniques must be fused in assembling forms then it is anything but difficult to improve Environmental Performance. Some different creators have likewise depicted a similar view that responsibility can improve execution in programs and those projects can be about Environmental Performance.

Secondly, this study shows that enhancing the technological innovation manufacturing process is crucial since it improves both environmental and economic performance. Raising awareness of technical behavior through technology innovation and practice, as well as the environmental behavior of CEOs and employees, is crucial to improving technology innovation purpose and behavior. Additionally, social media advertising must be used to highlight the significance of environmental management. (Oh, Xingle, Yaqiong Chen, Jianguo Du, Keunyeob, Long Insoo Han, Jinhua Yan 2017). The findings show that conformity with ecological rules is the most robust forecaster of the

model. Attention of market and the technologies employed has been established as a driver that positively affects the performance of environment. (Yudi Fernando, Wen Xin Wah 2017).

Thirdly, our study indicates that the conservative effect of green contributions on the connection between green product and innovation and the financial outcome of the corporation is not sustained. On the base of these results, we give numerous suggestions to managers and government agencies to productively perform green technology innovation (XuemeiXiea, JiageHuob, Hailiang Zouc 2019). To raise the environmental performance environmental innovation can be used as a platform. As a result of environmental innovation, companies will reduce the amount of solid / liquid waste produced and greenhouse gas emissions. Businesses must be conscious of their part in unattainability in order to improve environmental efficiency. If a company effectively implements an eco-innovation strategy in its surroundings, it will received financial benefits (Yudi Fernando, Wen Xin Wah 2017).

Lastly, we suggest that a firm's technology process innovation processes are conducive to boost its financial performance. Early, technology innovation enhance current production procedures or adds new procedures to mitigate financial affects, hence enhancing financial conformity of firm and reaping the benefits of differentiation (Chengetal.,2014).Additionally, Xie et al. (2016) found that clean technologies and pipe-to-pipe technologies, which are important facets of technology process innovation, have a positive effect on economic progress. Results suggest that technological innovation initiatives could have consequences. In any case, improved financial performance is not a basic result of these consequences. As a result, even while businesses' efforts might result in new items, they won't spend for the short-term financial gain, which reflects the innovation's value and risky aspects. This study's goal is to contribute to discussions about the significant effects of invention in the milieu of a major emerging nation by combining experimental findings from the literature (Juliana et al., 2019).

### 5. Conclusion

The results of the study indicate that the connection between SMEs' financial resources and intellectual capital in Pakistan's growing market is significantly mediated by technological innovation. Innovation in technology is essential for SMEs to achieve high performance. SME's are more focused on the enterprise long view planning for technology innovation to get high financial and environmental performance. Financial resources and intellectual capital are the main resources which assist enterprises to develop their services and products to achieve superior performance. The importance of the financial resources and intellectual capital is existence continued and firm financial and environmental performance of SME's through technology innovation strategies, which are more important for all the firms.

### 6. Implication for practice, Limitations and Directions for Future Research

#### Managerial Imperatives for SME Executives

##### De-risking Sustainable Transitions through R&D Allocation:

Managers often perceive green practices as a net cost burden that threatens immediate survival. However, the empirical data proves that financial resources directly catalyze technology innovation ( $\beta = 0.21$  to  $0.32$ ), which subsequently yields dual dividends: reducing environmental burdens while stabilizing financial performance. Therefore, SME executives must strategically allocate liquid capital toward technology-driven process modifications rather than treating environmental compliance as an isolated, non-recoverable expense.

##### Capitalizing on Intellectual Capital as a Low-Cost Innovation Engine:

For resource-constrained SMEs unable to match the heavy financial spending of larger corporations, Intellectual Capital (IC) serves as a potent, low-cost substitute. Because IC exerts a massive direct effect on technology innovation ( $\beta = 0.75$ ), firms should actively mobilize internal employee know-how and tacit knowledge to design cleaner, cost-saving production workflows.

**Deploying Eco-Management Systems (EMS) for Data-Driven Efficiency:** Rather than implementing ad-hoc green steps, managers should adopt structured Environmental Management Systems. An EMS acts as a vital operational mechanism to eliminate internal information asymmetries, allowing firms to precisely identify and capture cost-saving opportunities in material consumption and energy usage.

#### Macro-Level Policy Frameworks for Regional Authorities

##### Transitioning from Penalties to "Green Credit" Ecosystems:

Policymakers should transition from purely punitive measures (such as escalating environmental fines) to market-driven financial incentives. Establishing institutionalized "Green Credit" lines through regional commercial banks will prioritize capital access for technologically innovative, eco-compliant SMEs while restricting credit to heavy polluters.

### **Targeted Industrial Subsidies via Chamber Collaborations:**

Since a vast majority of new businesses collapse early due to resource scarcity, the government should partner with regional industrial bodies—such as the Islamabad and Rawalpindi Chambers of Commerce—to offer targeted financial subsidies specifically earmarked for sustainable technology adoptions.

### **6.1 Methodological Constraints & Sampling Boundaries**

#### **Geographical and Institutional Clustering:**

A primary boundary of this study is its localized empirical scope, with data strictly gathered from registered SMEs within the Islamabad and Rawalpindi chambers. Consequently, the findings lack immediate generalizability to broader socio-economic or rural industrial clusters across Pakistan.

**Future Direction:** Future researchers should validate this model across diverse, high-density industrial hubs (e.g., Karachi, Lahore, Sahiwal, or Sialkot) to compare how regional infrastructure alters the technology innovation path.

#### **Sample Horizon and Cross-Sectional Limitations:**

This study utilizes a cross-sectional approach, capturing corporate metrics at a single point in time. Because the financial returns on technology innovation and structural shifts in environmental reputation materialize over extended lifecycles, cross-sectional data cannot fully capture long-term causal trajectories.

**Future Direction:** Future studies should adopt a longitudinal research design, tracking a panel of SMEs over a 3-to-5-year horizon to evaluate the post-adoption financial impacts of eco-innovations.

#### **Sample Size Variance:**

Although statistically sufficient for initial model validation, the final sample size ( $N = 157$ ) limits the robustness of higher-order multi-group analyses.

#### **Future Direction:**

Replicating the model with an expanded sample framework ( $N > 300$ ) would minimize bootstrap standard errors and increase structural path reliability.

### **6.2 Analytical and Conceptual Refinements**

#### **Omission of Organizational Control Variables:**

While the descriptive profile reveals sharp variations in firm size (employee brackets), age, and industry classification (Manufacturing vs. Trading vs. Services), these characteristics were not incorporated as control or moderating variables within the structural models.

#### **Future Direction:**

Future inquiries should introduce "Firm Size" and "Industry Type" as explicit moderating variables using multi-group structural equation modeling (MGA-SEM) to determine if the mediation path of technology innovation varies between service sectors and heavy manufacturing setups.

#### **Unidimensional Aggregation of Intellectual Capital:**

This study treats Intellectual Capital as a single, unidimensional construct, despite the literature review establishing its distinct sub-dimensions: human, structural, and relational capital.

#### **Future Direction:**

To provide granular insights for corporate strategy, future research should deconstruct IC into its components—or specifically focus on Green Intellectual Capital—to isolate which specific dimension has the strongest predictive validity for technological process innovation.

#### **Statistical Ambiguities in the Text:**

For publication clarity, a structural discrepancy must be resolved: the abstract and text assert that technology innovation fully mediates the path between IC and financial performance, yet the empirical macro results in Table 3 clearly demonstrate a significant direct effect ( $\beta = 0.27, p = 0.01$ ) alongside the indirect effect, which mathematically defines partial mediation.



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### **Future Direction:**

Researchers must ensure exact alignment between conceptual interpretations and standard statistical definitions before journal submission to prevent immediate reviewer flags.

### **Conflict of interest**

The authors declare that they have no conflict of interest.

### **Ethical approval**

This article does not contain any studies with animals performed by any of the authors.

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This study did not receive any funding from any organization.

### **Informed consent**

Informed consent was obtained from all individual participants included in the study

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