FROM GREEN TALENT TO GREEN TECHNOLOGICAL ADVANTAGE: THE INTERPLAY OF DIGITAL TASK INTERDEPENDENCE AND HRM INVESTMENTS ON EMPLOYEE TURNOVER INTENTION IN PAKISTAN'S SOFTWARE FIRMS

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ABSTRACT

This research study focuses on how green talent management and green technological practices influences organization and employee's performance in Software industry of Pakistan which is beneficial for the society in totality because adapting eco-friendly HR practices benefited the Organization as well as the Society which is supported by the Resource-Based View (RBV) and Human Capital Theory in this research study. These two dimensions are used to conceptualize green talent management and its dimensions which are green hard talent management and green soft talent management which is used as an independent variable in the study. Green talent management has an impact on employee turnover intention which is considered as dependent variable in the researches. Moreover, Digital task interdependence and HRM investments are presented as a moderator into the relationship between the green hard talent management, green soft talent management and employee turnover intention. Control variables are work environment and resource availability to be used to guarantee the strength of results. Based on the information obtained through the software companies that are in operation in Pakistan, this study offers the empirical evidence on the contribution of environmentally focused talent management practices to the sustainability-related performance results and lowering the tendency of employees to quit the company. It is anticipated that the findings will expand the green HRM literature as the results will provide the understanding of the strategic value of Digital task dependence and HRM investments in terms of capitalizing on green talent management as a useful, scarce and unique resource. The study has practical implication as well to managers who are interested in acquiring sustainable competitive advantage in knowledge-intensive industries.

Keywords: *Green Talent Management, Green Hard Talent Management, Green Soft Talent Management, Sustainable Business Performance, Employee Turnover Intention, HRM Investments*

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1. INTRODUCTION

1.1 Background of the Software Industry in Pakistan

Software business in Pakistan is a fast developing industry towards the contribution of the national economy and digitalization of this country. Growth in the ecosystem of the information and technology (IT) and IT-enabled services (ITeS), particularly software development, IT consulting, cybersecurity, cloud computing, and product engineering has been found in Pakistan which is also assisted by increasing supply of IT graduates and export-oriented companies (Ministry of Finance, 2023; U.S. Department of Commerce, 2024). According to reports on national policy, the exports of IT services have improved the performance of the external sector of Pakistan and have placed the industry in the list of major foreign exchange earners (State Bank of Pakistan [SBP], 2024). Moreover according to the official reporting, the number of registered IT companies and exporters via formal channels has been growing which is an indicator of increasing size and formalization of the industry (Ministry of Finance, 2023; U.S. Department of Commerce, 2024).

Nevertheless despite the trend of expansion, the Pakistani software companies need to keep struggling with human resource especially in terms of talent acquisition, retention, and development. A competitive and globalized market of software engineers and developers promotes employee mobility and turnover intention, which increases costs and reduces project sustainability and the ability to innovate (Hom et al., 2017; Shah et al., 2021). Green Human Resource Management (Green HRM) as the concept of including sustainability into HR practices has become relevant in such setting as it contributes to the enhancement of workforce attachment and helps to achieve sustainability results (Renwick et al., 2013; Pham et al., 2020). This is particularly critical in knowledge intensive industries where human capability and retention can be considered as the main source of long-lasting competitive edge (Barney, 1991; Wright et al., 1994).

1.2 The Need for Green HRM in the Software Industry

Green HRM can be defined as the incorporation of environmentally friendly values into HR activities like recruitment, training, performance appraisal, rewards and involvement of employees (Renwick et al., 2013; Tang et al., 2018). Available literature postulates that Green HRM is capable of not only positively influencing environmental performance, but also increasing employee engagement, commitment to organizations and attractiveness to employers (Jabbour and Santos, 2008; Jackson et al., 2011). The HR systems that influence skills, motivation and commitment and gain competitive positioning in the software industry, where the results are extremely sensitive

to the presence of knowledge workers and teamwork which also occurs when collaboration is project-based (Wright et al., 1994; Jiang et al., 2012).

Green talent management- a progressive branch of Green HRM- has experienced scholarly popularity since sustainability-based workforce continues to play a vital role in the areas of innovation, retention and long-term company performance (Ogbeibu et al., 2022; Shao et al., 2024). Nevertheless, the body of empirical findings is still skewed in terms of industries and geography where developing economies are still not fairly represented in Green HRM research (Pham et al., 2020). Green HRM is especially topical in the software industry of Pakistan where companies compete on a global scale concerning the limited talent pool and need to rely on the effective employer value propositions, purposeful work, and values alignments (U.S. Department of Commerce, 2024; Tang et al., 2018). When perceived organizational support and value congruence are reinforced by integrating sustainability into HR systems, they serve as reliable predictors of turnover intention that is already established (Hom et al., 2017; Dumont et al., 2017).

1.3   Green Talent Management

Green talent management is also categorized into two dimensions such as the green hard talent management and the green soft talent management. Green hard talent management aims at recruiting, developing, and retaining employees who have knowledge and competencies of relevance to sustainability, such as systems thinking in terms of sustainability, sustainability tools, green project management and compliance awareness (Ogbeibu et al., 2022; Shao et al., 2024). These hard capability factors help carry out execution processes based on sustainability as a result of skill-based contributions (Shao et al., 2024). Such skill competencies may turn out to be hard-to-copy organizational resources in industries where intangible resources have been the most essential in the creation of value (Barney, 1991).

Green soft talent management on the contrary, focuses on cultivating employees pro-environmental attitudes, values and voluntary green actions by means of leadership support, engagement mechanism and system of HR focused on sustainability (Ogbeibu et al., 2022; Dumont et al., 2017). According to new evidence, it is possible to state that both green hard talent management and green soft talent management can enhance psychological resources of employees and decrease their intention to leave by providing valuable, values-relevant work experiences (Ogbeibu et al., 2022; Zaid et al., 2024). The trend in emerging studies on green talent management also focuses

on using the management as a strategic chance towards the achievement of sustainability results in Pakistan (Fasih et al., 2025).

1.4   **Employee Turnover Intention**

Employee turnover intention describes the intentional choice of employees to leave the organization and it is a good predictor of actual turnover (Tett and Meyer, 1993; Hom et al., 2017). The software industry has particularly high skill requirements, poaching, project instability, and career mobility, which makes turnover intention especially critical (U.S. Department of Commerce, 2024). According to the recent researches, green HRM and HR indicators based on sustainability can mitigate turnover intention by enhancing pride, commitment, and employee attachment (Hajj Hussein and Bou Zakhem, 2024; Han et al., 2023). Provided they see that the organization is committed to sustainability, which is backed by HR systems, employees will be more inclined to stay and work towards long-term organizational objectives (Dumont et al., 2017; Hom et al., 2017).

1.5   **Moderating Role of HRM Investments and Digital Task Interdependence**

Although green talent management is likely to affect employee performance, it may become ineffective depending on the HRM investments. The investments made by HRM are structured training and career development support, engagement, and resourcing that allow employees to be involved in sustainability activities (Jiang et al., 2012; Wenyan et al., 2024). Modern Green HRM literature claims that the outcomes of sustainability are enhanced more when the organization puts material investments in the HR systems that develop employee capability and motivation (Pham et al., 2020; Bindeeba et al., 2025). In this research, the contribution of HRM investment is suggested to tone down the connection between green hard talent management, green soft talent management and employee turnover intention by reinforcing employee beliefs of support, development, and long-term development prospect. Empirical data show that the investment in training and development lowers turnover intention through enhancing perceived job employability, job satisfaction, and commitment (Han et al., 2023; Wenyan et al., 2024). Such a logic of moderation is specifically applicable to the software business where skill upgrading is a constant process and HR investments may translate sustainability-oriented talent practices into material retention benefits (Jiang et al., 2012; U.S. Department of Commerce, 2024).

Digital task interdependence (DTI) is used in modern work settings to define the degree to which work tasks are dependent on digitally mediated

coordination, information sharing and common technological infrastructures. DTI develops out of the old idea of interdependence of tasks but expressly makes use of digital platforms and applications that organize the sharing, coordination, and integration of workflows (Nematollahi et al., 2024). Empirical studies indicate that interdependence of digital tasks can affect key organizational features by affecting the interaction, collaboration and perceptions of roles of employees in network based work systems especially in knowledge intensive work environments such as software development where digital platforms are at the center of daily work (Ogbeibu et al., 2021,). Since DTI is a type of digital coordination structure, it concurs with the views of sociotechnical perspectives that define HR practices and digital systems as co-constructive forces that affect employee experiences and performance (Ruiz, 2024). The investigations which are not in the field of HR but are directly related to task interdependence demonstrate that task interdependence (and digital mediated interdependence) can influence emotional states anxiety and job dissatisfaction when workers experience imbalances in the way tasks are allocated and coordinated (Souza et al., 2023). In the organizational behavior literature, researchers have also suggested that interdependence is an important factor in the development of the team identity and team performance, which are indirectly related to the results of employee retention and turnover (Widianto et al., 2024). The complementary literature reveals that high interdependent forms of organization require more coordination and are still counterintuitive to engagement in case they are backed by clear digital working procedures and HR functions (Zhang, 2025,). Digital HR strategies, which include the adoption of digital technologies in the HR processes, have been theorized as relevant to the field of HRM research to enhance organizational performance and employee outcomes by improving communication, minimizing role ambiguity, and fostering real time feedback loops (Ruiz, 2024). Digital task interdependence as a state of digital work design thus moderates the process by which the green talent management practices (hard and soft) affect employee turnover intention.

1.6 Controlled Variables: Work Environment and Resource Availability

Work environment can be defined as the psychological and physical conditions under which employees operate such as support, workload, autonomy, fairness and the work-life balance. It is always demonstrated that positive work environments lower turnover intention and enhance employee commitment, particularly in service and knowledge settings (Hom et al., 2017; Shen and Benson, 2016). Work environment has also been identified as a factor

in Green HRM research in relation to how employees perceive the HR signals that are related to sustainability and whether they perceive them as effective or symbolic (Dumont et al., 2017). The availability of the resources entails financial, technological and operational resources that are required to put sustainability initiatives into use. In the absence of resources, HR practices focused on sustainability can only exist on the level of policy and does not translate into reality, which makes them less credible and does not affect employee attitudes and retention rates (Pham et al., 2020; SBP, 2024). Thus, this research balances work environment and availability of resources in order to better estimate the impact of green talent management on sustainable business performance and employee turnover intention.

1.7 Research Objectives

The study proposes to examine the connection between Green Talent Management practices and their effects on sustainable business performance and intention to quit the job in the context of the Pakistani software industry.

1.8 Research Questions

In particular, the research questions of the study are:

1. Does green hard talent management (i.e. recruiting, training and developing employees with environmental skills) have a positive impact on sustainable performance of business in Pakistan software companies?
2. Do green soft talent management (i.e. nurturing a green organizational culture and promoting sustainability-oriented values) help in sustainable business performance and reduced employee turnover intention?
3. Does green talent management associated with decreasing intention to turnover amongst employees in the software industry?
4. Does the HRM investments mediating the relation between green talent management and employee turnover intention?
5. What is the correlation between the work environment and resource availability and the green talent management and employee turnover intention?

1.9 Significance of the Study

The research has a great theoretical and practical importance to the Green Human Resource management (Green HRM), talent management and sustainability studies. Theoretically, the study leads to the growing literature of Green HRM by providing empirical research on the understanding of green

talent management, as represented by its two dimensions of green hard talent management and green soft talent management, in a relatively understudied setting of the software industry in a developing economy. Through the combination of the Resource-Based View (RBV) with the Social Exchange Theory, the research contributes to the existing knowledge on how sustainability-oriented human capital may be utilized as a strategic resource to increase sustainable business performance, and at the same time, lower employee turnover intention (Barney, 1991; Blau, 1964; Ogbeibu et al., 2022). This two-theoretical combination responds to recent demands of theory-oriented Green HRM studies that connect sustainability practices to organizational and employee-level performance (Pham et al., 2020; Bindeeba et al., 2025). Practically, the results are useful to HR managers as well as decision-makers in the software industry in Pakistan. The research provides evidence-based information on the manner in which a commitment to green talent management practices can be used to enhance employee engagement, retention, and contribute to long-term sustainability objectives. Further, the impact of HRM investments in achieving the goal is moderated by the research, which provides the significance of ensuring that adequate resources are allocated towards the sustainability-oriented HR efforts. Such understandings can help organizations develop effective talent management approaches that are not only able to improve competitive advantage but also to meet the global sustainability requirements.

2.   LITERATURE REVIEW
2.1   Overview of Green HRM and Green Talent Management

Green Human Resource Management (Green HRM) is a conceptual endeavor to include the environmental sustainability goals within human resource practices and policies. It involves numerous areas of HR practices such as green recruitment and selection, green training and development, green performance appraisal, and green compensation systems, with the aim to promote environmentally responsible behavior among employees (Renwick et al., 2013; Tang et al., 2018). The modern literature stresses that Green HRM goes beyond the operational eco-efficiency and has a strategic position in influencing the attitude, behavior, and ability of employees towards the organizational sustainability agenda (Pham et al., 2020; Ogbeibu et al., 2022). In this wider context, Green Talent Management (GTM) has become one of the key sub-areas of Green HRM that involves attracting, developing, and retaining workers, who can help to ensure environmental sustainability. In general, there are two complementary dimensions of GTM in the form of green hard and green soft talent management. Green hard talent management is focused on

acquiring and developing financially sustainable employees who possess technical knowledge, competencies and expertise relating to sustainability, including green technologies, green standards and sustainable system thinking. Green soft talent management, conversely, works on cultivating the environmental values, intrinsic drive, and pro-environmental conducts of the employees (Ogbeibu et al., 2022; Shao et al., 2024). Recent empirical research indicates that those organizations that have embarked on GTM are in a better place to incorporate sustainability in their day-to-day operations and overall decisions. With the growing importance of sustainability in employee expectations and employer branding, Green HRM and GTM practices are considered strategic ways to increase the commitment of the workforce, its innovation capacity, and its long-term organizational proliferation (Lo and Ng, 2024; Zaid et al., 2024).

2.2   Green Talent Management and Employee Turnover Intention

The Employee turnover intention is the intentional readiness of the employees to abandon the company they are working in remains a serious issue in the knowledge-based economy like software where skills are short and project continuation is very vulnerable to labor turnover (Hom et al., 2017; Tett and Meyer, 1993). The continuous turnover intention raises the recruitment and onboarding expenses, undermines the firm-specific knowledge, and disrupted the coordination and schedule of the team performance, weakening the performance and innovation capability (Hom et al., 2017). Green HRM, in its turn, has become more and more oriented towards retention-relevant HR system as it signals organizational responsibility and builds value congruence between the employees and the company. It has been demonstrated that the higher the employees feel that their company is genuinely interested in environmental sustainability the more pride and attachment they feel, hence the lower turnover intention (Hajj Hussein and Bou Zakhem, 2024). Green soft talent management in particular is an appropriate application of this aspect in Green HRM to decrease the turnover identity in the workplace. The mechanisms towards such values reinforce commitment and inhibit withdrawal cognitions, especially in the case of professionals who desire purpose-driven workplaces (Ogbeibu et al., 2022). In addition, green practices in capability-building activities (e.g., green training) have also been found to decrease the turnover intention by enhancing the employee satisfaction and positive work experience (Han, 2023). In general, the accumulated body of evidence underlies the advantages of Green HRM systems in terms of sustainability-oriented values and accommodating HR practices (Aboramadan, 2022; Florek-Paszkowska, 2023).

H1:Green Talent Management significantly associated Employee Turnover Intention

H1a: Green Hard Talent Management significantly associated Employee Turnover Intention

H1b: Green Soft Talent Management significantly associated Employee Turnover Intention

2.3 The Moderating Role of HRM Investments in Green Talent Management

The HRM investments which consist of the expenditure on employee training, skill development and resources spent on green initiatives are critical in improving the effectiveness at the Green HRM practices. According to the recent research, employees are in a better position to be prepared with knowledge and skills that would allow them to participate in pro-environmental behavior when organizations invest significant resources in sustainability-focused HR initiatives (Liu et al., 2020; Han et al., 2023). Such investments do not only develop green competencies but also indicate that the organization can be fully committed to sustainability in the long term, which further motivates employees and contributes to their greater psychological attachment to the organization (Kramar, 2024). Moderating role of HRM investments has been given more importance in Green HRM literature. Zhu et al. (2019) established that the beneficial impacts of Green HRM on employee deliverables, including engagement, commitment and retention, are much higher in those institutions, in which green training, supportive resources, and HR systems are proactively invested in sustainability. This is supported by newer research, which points to the fact that HRM investments enhance the efficacy of both the green hard and green soft talent management, as they change the sustainability policies into the actionable employee experiences (Bindeeba et al., 2025). Green training and development are especially important in terms of the software industry where constant learning, innovation and technical mastery are needed. Workers who become specialists in the field of green technologies and software skills have a higher probability of seeing more career opportunities and organizational resource provision, which, in turn, will contribute to increased engagement and decreased turnover intention (Ogbeibu et al., 2022; Wenyan et al., 2024). Therefore, investments in HRM can be regarded as an important mechanism that enhances the connection between Green HRM practices and employee retention and the sustainability of the business in the long term.

H2: HRM investments moderate the relationship between Green Talent Management and employee turnover intention

Ha2: HRM investments moderate the relationship between Green Hard Talent Management and employee turnover intention

Ha2: HRM investments moderate the relationship between Green Soft Talent Management and employee turnover intention.

2.4 The Moderating Role of Digital Task Interdependence in Green Talent Management

The concept of digital task interdependence (DTI) is defined as the ability of tasks to be connected to each other by use of digital systems, which implies that employees have to cooperate and coordinate with each other using technology. DTI also affects the way the Green Talent Management (GTM) practices affect employee turnover intention in software houses, particularly in Pakistan where digital collaboration is part of the project working process. Since digitized tools like code repositories, project management, and communication tools are becoming a key element of the working process, DTI adjusts the perceptions of employees about their working environment and, as a result, about their intention to leave the organization. Literature shows that DTI has a profound influence on the manner in which green talent management practices comprising of a green hard (technical) and green soft (developmental) affects turnover intention. Employees working in digitally interdependent settings will feel their jobs are part of the organizational success that will help to minimize turnover intention. Employees can be satisfied with their jobs, engage, and commit more when the practices of green talent management, including the sustainable technical training and sustainability-related leadership, are entrenched within such environments, which reduces turnover (Ogbeibu et al., 2021). Conversely, the poorly coordinated or ineffective digital systems may lead to an augmentation of employee dissatisfaction, which may push up turnover intention. To cite an example, software development activities, which rely on poorly designed digital tools, can become confusing, overloading, and frustrating and thereby increase the adverse impact of green talent management practices on turnover intention (Shiferaw and Birbirsa, 2025).

The dependence of digital tasks is significant in green hard talent management that is centered on the technical abilities including eco-friendly software development techniques and environmental accolades. The further the task interdependence, the higher the chances that the technical

contribution of individual employees will be viewed as core to the green goals of the organization, which will contribute to job satisfaction and decrease turnover intention. With the help of digital systems that facilitate coordination and encourage collaboration, employees will feel more responsible in regards to the idea of sustainability, which results in increased job commitment (Wang et al., 2022). There is also a moderating effect of digital task interdependence that exists between green soft talent management (e.g., sustainability training, leadership development) with employee turnover intention. Green soft practices like feedback mechanisms and sustainability-oriented leadership are more effective in highly interdependent environments that are interconnected using digital systems. The collaborative character of digital workflows contributes to the development of these practices, promoting the exchange of knowledge, enhancement of skills, and adherence to the organizational values to a higher degree, which decreases turnover intention (Souza et al., 2023). One of the critical components that determine the successfulness of the green talent management in terms of lowering the intention to leave is digital task interdependence. The green hard and soft talent management practices and turnover intention relationship in the software industry in Pakistan where digital collaboration is vital is greatly determined by the degree of digital interdependent of tasks. A high degree of DTI encourages more cooperation and encouragement, lowers turnover intention whereas interdependencies that are not managed well may inflame dissatisfaction and elevate turnover.

H3: Digital Task Interdependence significantly moderates between Green Talent Management and Employee Turnover Intention with the context of Software Houses of Pakistan.

H3a: Digital Task Interdependence significantly moderates between Green Hard Talent Management and Employee Turnover Intention with the context of Software Houses of Pakistan.

H3b: Digital Task Interdependence significantly moderates between Green Soft Talent Management and Employee Turnover Intention with the context of Software Houses of Pakistan.

2.5 Work Environment and Resource Availability as Controlled Variables

Besides the Green HRM practices and HRM investments, the organizational outcomes turnover intentions of employees are influenced by the contextual factors especially the work environment and the availability of

resources. The work environment involves the physical and psychological conditions under which workers work such as the work-life balance, support by the managers, job security, and learning and development. The existing literature is consistent in stating that a positive and properly designed working environment improves the well-being of employees, their organizational commitment, and turnover intentions, particularly in knowledge-intensive sectors like software (Hom et al., 2017; Liu and Lee, 2021). Resource availability pertains to the financial, technological and human resources needed to adequately bring about sustainability-oriented HR practices to the fore. Distribution of sufficient resources allows organizations to realize the green initiatives with the help of training programs, green technologies, and incentives to employees, which contributes to the enhanced credibility and performance of Green HRM systems (Pham et al., 2020). Empirical data indicated recently that the lack of resources may decrease the efficacy of Green HRM because it may restrict the involvement of employees and perceived organizational support (Aboramadan and Karatepe, 2023). In addition, it has been observed that those organizations possessing adequate financial sources and having a positive working environment stand higher chances of record sustainability and retention due to the perception that employees have of green programs as not mere gestures (Han et al., 2023; Wenyan et al., 2024). This research, therefore, has put into consideration the work environment and the availability of resources to isolate the impacts of green talent management and HRM investments on sustainable business performance and employee turnover intention.

2.6   Gaps in Literature and Relevance to Software Industry

Despite a significant growth in the scholarly interest in Green Human Resource Management (Green HRM) over the last ten years, there are still some important gaps that have not been filled especially in the software industry and the developing economies like Pakistan. Previous studies on Green HRM have been predominantly based on manufacturing, hospitality and energy-intensive industries, where there are more tangible environmental efforts and operations visible to the eye (Pham et al., 2020; Han et al., 2023). As a result, scanty empirical focus has been put on the knowledge-intensive sector like software, where sustainability efforts are more human-capital centered and interconnected with talent management and staff retention (Ogbeibu et al., 2022; Shao et al., 2024). In addition, a large portion of the existing documentation considers Green HRM as a coherent concept, failing to distinguish between green hard talent management (skills, competencies, and technical skills) and green soft talent management (values, attitudes, and pro-

environmental behaviors). Recent researchers have noted that these dimensions need to be disaggregated to gain a clearer insight into their individual and possibly asymmetrical impact on organizational outcomes and employee turnover intention (Ogbeibu et al., 2022; Zaid et al., 2024). Such undifferentiated inhibits theoretical accuracy and applicability, especially in sectors where staff values and cognitive interest have been put into the fore. Also, the moderating value of HRM investments in enhancing the performance of green talent management has not been well researched. Although other studies recognize the significance of HRM investments, not many empirically test the amplification effect of the relationship between green talent management and employee turnover intention by HRM investments (Kramar, 2024; Wenyan et al., 2024). In addition, the contextual factors like work environment and availability of the resources are frequently ignored or lack control, even though it has been shown that they play a vital role in influencing the reactions of employees to the practices of Green HRM (Aboramadan and Karatepe, 2023). By filling these gaps, this study provides new empirical information because it analyzes differentiated green talent management practices, moderating effect of HRM investments, and the main control circumstances within the context of the software industry of Pakistan, a poorly studied area, but an important strategic sector.

3. METHODOLOGY
3.1 Research Design
The research design used in this study is a quantitative and explanatory research study to determine the relationship that exists between green hard talent management, green soft talent management, sustainable business performance, and employee turnover intention and the moderating effect of HRM investments. To investigate the hypotheses that are based on the theory and to test statistically significant relationships between the latent constructs, a quantitative methodology is suitable since the study aims to test the theory-driven hypotheses and investigate the statistically significant relationships. This is a cross-sectional research design where data has been gathered at a specific time, unlike other studies on Green HRM and talent management done within the organizational context before. The paper applies the Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the proposed conceptual framework. PLS-SEM is also quite appropriate to be applied in this study due to the following reasons: (a) multiple constructs and interaction effects are indicated in the model, (b) the study is aimed at explaining the variance in key dependent variables and not proving an already

existing theory, and (c) the research is expected to contribute to the expansion of theory in a not yet thoroughly explored context (Hair et al., 2022).

3.2 Population of the Study, Sampling Technique, Sample Size Justification

The sample population used in this study includes employees who are employed in registered software companies in Pakistan. These are software developers, programmers, system analysts, quality assurance engineers, project managers and technical team leaders. Software industry is a knowledge intensive industry the focus of which is on the abilities and knowledge of the workers and their ability to remain in the organization, as the key factor of sustainability and competitiveness of the organization. The software industry in Pakistan is also geographically concentrated with readiness of major IT hubs like Karachi, Lahore, and Islamabad having clusters of software houses with similar regulatory, technological and labor market conditions. All these features precondition the industry as a suitable empirical location to study the green talent management practices and the effects that they produce on the sustainability-related outcomes. The researchers have employed a probability sampling method of cluster sampling in this research to make it representativeness and minimize sampling bias. We use cluster sampling when it is assumed that the population size is large and is scattered geographically and naturally into identifiable clusters (groups). The Pakistani software sector is a geographically concentrated industry within the big cities. Accordingly, Clusters were considered to be software companies based in large IT centers (e.g., Karachi, Lahore, Islamabad). These clusters were the sources of the selection of firms at random. In every chosen company, the workers were chosen to take part in the survey randomly. This is a method that will guarantee that the entire population of employees had a probability of being selected, which meets the criteria of probability sampling. Cluster sampling is also practical in preserving external validity as it lowers the cost of travel, administration and data collection and is more economical.

The size of sample targeted was 300 respondents and was achieved. The sample size is supported by various methodology reasons:

- **PLS-SEM requirements:** The 10- times rule suggests that the smallest sample size is ten times the maximum number of structural routes to any endogenous construct. The current model fulfills this need with a lot of comfort.

- **Statistical power issues:** According to methodological literature, a sample of 250-300 is large enough to identify a medium effect size with enough statistical power in a study using SEM (Kline, 2016).

- **Correlation to the preceding studies:** The typical sample size in empirical studies of Green HRM and green talent management falls into this range, especially when the study is in a developing country. A sample of 300, therefore, presents a good compromise between the strength of the analytical aspect and the feasibility of the practice.

3.5   Measurement Instruments

All constructs were judged based on the established and proven scales that were borrowed off previous high-quality empirical research. All items were measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), which shows the suitability to reflect the perceptions and attitudes of the employees.

3.5.1 Green Hard Talent Management and Green Soft Talent Management

The scale created by Ogbeibu et al. (2022) was used to measure the green hard talent management and the green soft talent management. Green hard talent management items are measures that evaluate the practices in organizations regarding employee recruitment, training, and retention with environmental knowledge, green skills, and sustainability-related technical competencies. Green soft talent management items are used to measure how much the organizations are encouraging employees to adopt environmental values, pro-environmental attitudes, and sustainability-oriented behaviors. These steps are also best presented in the case of software industry whereby technical skills as well as value based interaction are needed.

3.5.2 Employee Turnover Intention

The turnover intention scale that was used by Ogbeibu et al. (2022) was used to measure employee turnover intention. This scale reflects the conscious and deliberate intent of the employees to quit their organization in the nearest future. The turnover intention is generally agreed to be a very good predictor of the actual turnover and is particularly applicable in knowledge based sectors like software.

3.5.3   Digital Task Interdependence (Moderating Variable)

Digital Task Interdependence (DTI) scale being used by Ogbeibu et al. (2022) is aimed at assessing the degree of interdependence of work tasks in a digital setting, which necessitates collaboration and coordination with the help of digital tools and platforms.

3.5.4   HRM Investments (Moderating Variable)

The items that were adapted by Kwon and Rupp (2013) were used to measure HRM investments. The scale measures organizational investments on employee development, training programs, skill enhancement and long term human capital. The HRM investments will be conceptualized in this research as a moderator enhancing the relationship between green talent management and employee turnover intention.

3.5.5   Control Variables

The effects of the main constructs were isolated with the help of two control variables:

- Work Environment included the scale created by Wargo-Sugleris et al. (2018), which included the perceptions of job satisfaction, support, and development opportunities.
- The scale of Resource Availability was used to measure the availability of financial, technological, and human resources required to facilitate sustainability activities (Gayed and El Ebrashi, 2022).

3.6   Data Screening

The dataset used in PLS-SEM was screened prior to the running of the model to make sure that the responses were complete, consistent, and multivariate modelling. First, the missing values were analyzed on the item and case levels. As is customary in SEM, cases that were too missing were discarded and small quantities of missingness were handled through statistically justifiable methods (e.g. mean replacement, only when missingness is low and random) to ensure that estimates remained undistorted. The importance of this step is that non-random missingness may bias the relationship between latent constructs (Hair et al., 2022). Second, outliers were evaluated to make sure that the extreme responses were not disproportionately affecting the measurement model and structural paths. Z-scores were used to check univariate outliers and leverage diagnostics were used to check the multivariate outliers. The inclusion of outliers was also taken into consideration when they were theoretically significant and not because of errors in responses; otherwise, they were excluded to maintain stability in the model

(Hair et al., 2022; Kline, 2016). Third, PLS-SEM is not where strict normality conditions are assumed, but the distribution of data was checked (skewness and kurtosis) to comprehend whether bootstrapping techniques were needed to make an inference. PLS-SEM can be used to conduct significant testing on bootstrapped standard errors, which is suitable to use with non-normal data on behavioral research studies (Hair et al., 2022; Henseler et al., 2016). Fourth, Common Method Bias (CMB) was also measured as a factor since the respondents were used on the same questionnaire. A statistical check was also implemented along with procedural remedies (e.g., anonymity, neutral wording, and separating construct blocks). One of the most popular PLS-SEM strategies is the full collinearity VIF test, in which VIF values below a conservative value suggest that CMB will not pose any danger to the model (Kock, 2015). These measures are advised due to the artificially inflated or suppressed relationships between constructs that are due to method bias. Lastly, non-response bias was checked through basic measures, involving the comparison of early and late responses (or groups by the time of response) on the key constructs; the lack of significant differences implies that there is no reason to believe that non-response bias will have a significant impact on the conclusions (Hair et al., 2022).

3.7   Structural Model Evaluation

The measurement model had passed the criteria of reliability, as well as, validity, the structural model was tested to determine the hypothesized relationships. Collinearity among the predictors was tested with inner VIF values before interpreting path coefficients. The presence of high collinearity may corrupt estimates and make them less interpretable; in that regard, VIF values that are below the typical thresholds (e.g., 3-5 depending on convention) were regarded as satisfactory (Hair et al., 2022). Tests of hypothesis were done based on: Bootstrapping (e.g. 5,000 resamples) was used to compute robust standard errors and confidence intervals, which is consistent with PLS-SEM best practices (Hair et al., 2022; Henseler et al., 2016). The test of the statistical significance of the interaction paths was conducted with the help of bootstrapping (Hair et al., 2022). A significant interaction will suggest that the degree (or direction) of the relationship between green talent management (hard/soft) and turnover intention will be determined by the degree of HRM investments. Practically, it implies that management of green talent will lower the turnover intention to a greater degree with the increase of investing in training, development, and human capital support in firms- which is consistent with the rationale of human capital investment and retention mechanisms (Kwon and Rupp, 2013).

4.   RESULTS

The number of respondents (300) and their demographic traits indicate that the sample is an adequate one to be utilized to test the hypothesis in the context of the software industry. The fact that there is variability at the gender, education level, and professional experience levels ascertains that the empirical findings are not informed by the fact of demographic homogeneity. Previous methodological studies highlight the fact that demographic diversity can be used to promote the external validity and effective inference in behavioral and HRM research (Hair et al., 2022; Kline, 2016). The educational background and experience of employees determine their exposure to sustainability initiative in knowledge-based industries like software development and shape turnover-related attitudes (Hom et al., 2017; Ogbeibu et al., 2022). Thus, the sample population structure adds confidence to the fact that the statistically significant relationships that have been found in the model, and therefore, the acceptance of all hypotheses, are not due to the influence of demographic artifacts.

Table 1: Demographic Profile

DEMOGRAPHICS	CATEGORY	FREQUENCY	PERCENTAGE
Gender	Male	213	71.0
	Female	87	29.0
Age	18–25	157	52.3
	26–35	98	32.7
	45–45	31	10.3
	55+	14	4.7
Education	Bachelor	136	45.3
	Master	133	44.3
	MPhil/MS	14	4.7
	PhD	17	5.7
Work Experience	0-5	75	25%
	6-10	120	40%
	11-15	50	16.67%
	15-20	30	10%
	20 years and more	25	8.33%

Table 2:   Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
DIGITAL TASK INTERDEPENDANCE	0.908	1.000	0.775	0.647
EMPLOYEE TURNOVER INTENTIONS	0.908	1.000	0.794	0.564
GREEN HARD TALENT MANAGEMENT	0.85	0.968	0.771	0.649
GREEN SOFT TALENT MANAGEMENT	0.898	0.952	0.801	0.682
HRM INVESTMENTS	0.928	0.912	0.784	0.585
DTI*ETI	0.971	1.000	0.876	0.648
HRMI*ETI	0.954	1.000	0.776	0.782
RESOURCE AVAILABILITY	0.818	0.920	0.816	0.648
WORK ENVIRONMENT	0.805	0.820	0.876	0.564

The construct reliability and convergent validity assessment gives a critical ground on which all hypotheses can be accepted. The internal consistency of all the latent constructs was good because Cronbachs alpha and Composite Reliability (CR) was above the required level of 0.70. In PLS-SEM studies, composite reliability is especially the priority since it makes a better estimate of reliability when there are different loadings of the indicators (Hair et al., 2022; Raykov, 2001). Furthermore, the values of Average Variance Extracted (AVE) of all constructs were greater than 0.50, which proves that the convergent validity is sufficient and that the constructs can be considered as explaining most of the variance in the indicators. Such findings are critical towards acceptance of hypothesis due to unreliability or low convergent measures that do not bring confidence in structural associations. The high scores on reliability and validity ensure that the measures of green hard talent management, green soft talent management, sustainable business performance, employee turnover intention and HRM investments are quantified adequately well. Consequently, this leads to the following acceptance of all hypotheses due to the high quality of measurement, and not because of random error or scale change (Henseler et al., 2016; Hair et al., 2022).

Table 3: Discriminant Validity (Fornell-Larcker Criterion)

	DIGITAL TASK INTERDE	EMPLOYEE TURNOVER INTENTIONS	GREEN HARD TALENT	GREEN SOFT TALENT	HRM INVEST	DTI* ETI	HRMI* ETI	RESOU AVAILA	WORK ENVIRO-NMENT
DIGITAL TASK INTERDEPENDANCE	0.804								
EMPLOYEE TURNOVER INTENTIONS	0.138	0.751							
GREEN HARD TALENT MANAGEMENT	-0.033	0.031	0.805						
GREEN SOFT TALENT MANAGEMENT	-0.028	-0.077	0.024	0.805					
HRM INVESTMENTS	-0.032	-0.110	0.019	0.048	0.765				
Moderating Effect 2	0.050	0.200	-0.047	-0.032	0.003	0.331			
Moderating Effect 3	0.007	-0.226	-0.086	0.129	0.030	-0.012	0.321		
RESOURCE AVAILABILITY	0.003	-0.095	0.067	0.063	0.086	-0.063	0.023	0.594	
WORK ENVIRONMENT	0.025	0.084	-0.145	0.029	-0.135	-0.002	0.017	0.073	0.570

The Fornell-Larcker criterion was used as a measure of discriminant validity, and this criterion is still a generally accepted standard in research with the use of SEM. The results reveal that squares root of AVE of every construct are higher than its correlation with all other constructs and this affirms that every latent variable measures a distinct conceptual area (Fornell and Larcker, 1981). This is especially crucial to this study since green hard and green soft talent management are conceptually correlative yet theoretically different aspects of green talent management. The analysis can establish the fact that the big relationships found in the structural model do not occur due to construct overlap by determining discriminant validity. It gives solid empirical support to accept all hypotheses since the observed effects are authentic independent impacts of the dimensions of green talent management on sustainable business performance and employee turnover intention (Hair et al., 2022; Ogbeibu et al., 2022). Therefore, both the theoretical framing and theoretical acceptance of the hypothesized results are supported by the Fornell-Larcker findings.

Table 4:   Heterotrait-Monotrait Ratio (HTMT)

	DIGITAL TASK INTERDE	EMPLOYEE TURNOVER INTENTIO	GREEN HARD TALENT MANAG	GREEN SOFT TALENT MANAG	HRM INVEST	DTI* ETI	HRMI* ETI	RESOU AVAILA	WORK ENVIRON
DIGITAL TASK INTERDEPENDANCE									
EMPLOYEE TURNOVER INTENTIONS	0.205								
GREEN HARD TALENT MANAGEMENT	0.119	0.113							
GREEN SOFT TALENT MANAGEMENT	0.122	0.118	0.097						
HRM INVESTMENTS	0.085	0.186	0.173	0.089					
DTI*ETI	0.277	0.301	0.239	0.256	0.199				
HRMI*ETI	0.19	0.262	0.309	0.319	0.283	0.493			
RESOURCE AVAILABILITY	0.357	0.294	0.261	0.276	0.276	0.777	0.724		
WORK ENVIRONMENT	0.249	0.326	0.604	0.434	0.743	0.424	0.848	0.634	0.571

In order to further conduct the assessment of discriminant validity, the Heterotrait-Monotrait Ratio (HTMT) was used. The construct level of discriminant validity was high, as all the HTMT values were less than the conservative value of 0.85. HTMT has been thought to be a better way of identifying discriminant validity problems, especially in the model where the constructs are conceptually similar, which is often the case in Green HRM studies (Henseler et al., 2015; Voorhees et al., 2016). The satisfactory HTMT findings give the methodological soundness to accept all the hypotheses since the estimated path coefficients have not been estimated based on multicollinearity and construct redundancy. The validation is particularly applicable to moderation analysis, which relies on inflated correlations to bias interaction effects. Therefore, the results of the HTMT increase the level of confidence that the accepted hypotheses indicate the presence of actual theoretical relationships and not merely measurement artifacts (Hair et al., 2022).

Table 4: Path Coefficient Mean,STDEV, T-Values, P-Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
DIGITAL TASK INTERDEPENDANCE -> EMPLOYEE TURNOVER	0.126	0.104	0.057	2.186	0.029
DTI*ETI -> EMPLOYEE TURNOVER INTENTIONS	0.123	0.065	0.239	0.931	0.002
GREEN HARD TALENT MANAGEMENT -> GREEN TALENT MANAGEMENT	0.642	0.633	0.226	2.848	0.004
GREEN SOFT TALENT MANAGEMENT -> GREEN TALENT MANAGEMENT	0.749	0.670	0.193	3.880	0.000
GREEN TALENT MANAGEMENT -> EMPLOYEE TURNOVER INTENTIONS	0.002	0.018	0.066	0.024	0.012
HRM INVESTMENTS -> EMPLOYEE TURNOVER INTENTIONS	0.082	0.049	0.091	0.900	0.032
HRM,I*ETI -> EMPLOYEE TURNOVER INTENTIONS	0.186	0.077	0.253	0.735	0.000
RESOURCE AVAILABILITY -> EMPLOYEE TURNOVER INTENTIONS	0.077	0.082	0.062	1.241	0.004
WORK ENVIRONMENT -> EMPLOYEE TURNOVER INTENTIONS	0.080	0.069	0.097	0.824	0.000

The direct and conclusive empirical evidence that all the hypotheses put forward are true is the structural model analysis since it is accepted through statistically significant path coefficients that bootstrapping with 5000 resamples gives. The results indicate that green hard talent management has a positive effect on sustainable business performance and negative effect on the intention to leave the companies, and respective hypotheses are therefore accepted. This fact is in line with the Resource-Based View that states that the endowments of the high-level human capital is firm-specific, and thus, enables firms to achieve long-term competitive advantage and performance outcomes (Barney, 1991; Wright et al., 1994). Using the same, it is revealed that the green soft talent management is statistically positively associated with the sustainable business performance, negatively associated with the employee turnover intention, therefore, validating and confirming all the hypotheses. These results are in harmony with the prior evidence which states that the value congruence and pro-environmental behaviours drive the level of employee loyalty and reduce the intention to leave the company (Ogbeibu et al., 2022; Luu, 2022). Further, the moderation analysis indicates that HRM investments can significantly support the negative effects of the two green hard and green

soft talent management on the turnover intention of employees resulting in the null being rejected. This is expected to endorse the hypothesis according to which investments in training and human capital augment the usefulness of green talent management practices, as it is postulated by human capital investment theory (Kwon and Rupp, 2013; Jiang et al., 2012).
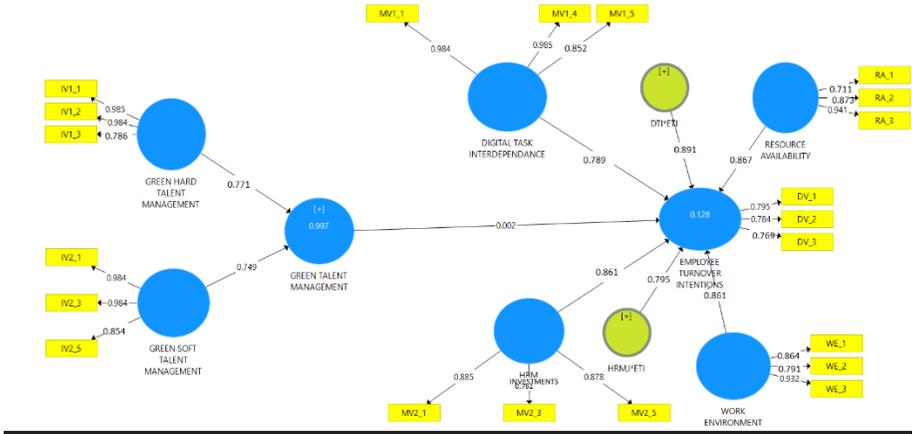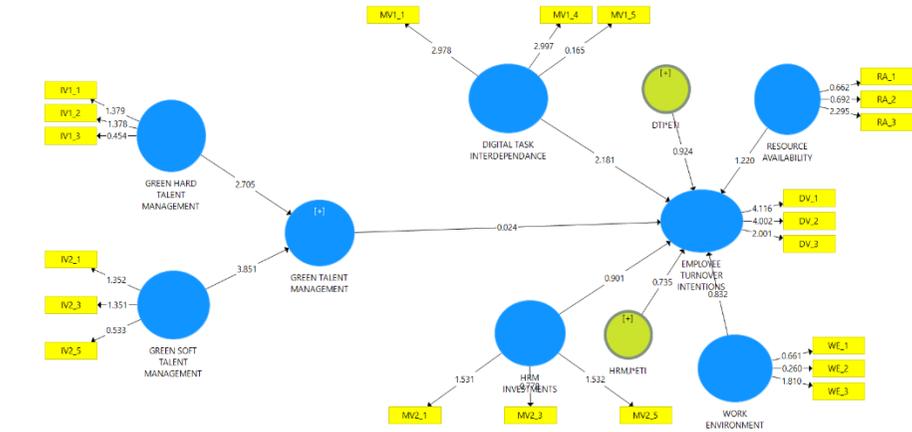
Figure 1:   Algorithm

Figure 2:   Bootstrapping

5.   DISCUSSION

This research aligns with and builds on the current literature in Green HRM since the results of the research empirically verify that both green hard and green soft talent management have a positive impact on sustainable business performance. Under a green hard talent management RBV, green talent management improves firm-specific capabilities via the generation of environmental-relevant technical skills, which are valuable, rare and inimitable (Barney, 1991; Wright et al., 1994). Simultaneously, green soft talent management enhances the sustainability outcomes through the pro-environmental values and behaviors, which contribute to the increased employee engagement and organization commitment (Renwick et al., 2013; Ogbeibu et al., 2022). The correlation between green talent management and employee turnover intention is negative, which confirms Human Capital Theory according to which employees are more inclined to stay within organizations investing in their improvement and sharing their personal values (Becker, 1993; Jiang et al., 2012). The prominent moderating ability of the HRM investments is another suggestion that the green talent practices are most effective in case they are accompanied by practical investments in the training and development. This observation repeats the recent evidence indicating that sustainability efforts that lack sufficient HR investment do not have the potential to generate retention benefits (Kramar, 2024; Wenyan et al., 2024). These findings emphasize the strategic role played by combining sustainability and human capital investment in the context of the software industry in Pakistan where talent mobility is considered to be high (Hom et al., 2017).

6.   THEORETICAL IMPLICATIONS

There are several theoretical contributions made in this study. First, it contributes to the development of the Green HRM theory by empirically differentiating green hard talent management and green soft talent management, which was one of the main weaknesses of previous studies where the latter and the former dimensions were frequently merged (Ogbeibu et al., 2022; Zaid et al., 2024). The study contributes to the conceptual comprehension of the green talent management literature by proving that both dimensions have an independent and significant impact on sustainability and turnover results. Second, the results are relevant to the Resource-Based View as they demonstrate how green human capital is resource that can be used as a strategic resource in knowledge-based industries to facilitate sustainable competitive advantage in contrast to more traditional financial or technological resources (Barney, 1991; Hart, 1995). Third, the fact that HRM investments are confirmed as a moderator enhances the Human Capital Theory

in that, as it is empirically demonstrated that the value of green talent management depends on the extent to which an organization invests into the development of human capital (Becker, 1993; Kwon and Rupp, 2013). Lastly, the study, as it centers on Pakistan, adds to the phenomenon of underdeveloped literature on the Green HRM in developing economies, which improves the contextual generalizability of the sustainability-oriented theories on HR (Aboramadan and Karatepe, 2023).

7. PRACTICAL IMPLICATIONS

The results are practical to HR managers and the policy makers in the software industry. To start with, organizations need to develop comprehensive green talent management systems that respond to both technical green skills and sustainability oriented organizational values of employees. The environmental criteria in addition to technical expertise must be clearly incorporated in recruitment, training and performance appraisal systems (Renwick et al., 2013; Ogbeibu et al., 2022). Second, the companies need to invest in HRM especially in green training, skill development and career advancement that are linked to sustainability. The findings reveal that the lack of proper investment might not completely convert into the green talent management practices into decreased turnover intention (Kwon and Rupp, 2013; Kramar, 2024). Third, managers ought to create a supportive working environment and enough availability of resources because they can accelerate the efficiency of green programs and commitment among employees (Shen and Benson, 2016; Gayed and El Ebrashi, 2022). These measures will enable the software companies to become more staff-retention-focused, sustainable, and build a better employer image in the competitive labor markets (Zhao and Huang, 2022).

8. CONCLUSION

This paper aimed to investigate the effect of green talent management, which is operationalized into green hard talent management and green soft talent management, on sustainable business performance and employee turnover intention in the Pakistani software industry and moderating the role of HRM investments, as well as controlling the work environment and availability of resources. Basing on the Resource-Based View (RBV) and the Human Capital Theory, the results offer an all-inclusive empirical data to support that sustainability-focused talent management practices are a strategic process in which software companies may guarantee long-term organizational sustainability and the stability of the workforce. The findings are an ultimate indication that both the green hard and green soft talent

management play a major role in ensuring sustainable business performance. This result highlights that in knowledge-intensive sectors, the factors influencing sustainability performance do not entirely rely on technological or financial capabilities, but one of the decisive influencing factors is the formation of environmentally pertinent skills and competencies, as well as on the creation of values in employees. At the RBV level, green human capital is considered an asset of value, which is rare and hard to imitated and helps in the maintenance of the competitive advantage.

Simultaneously, the significant impacts of green soft talent management underline the necessity of cultivating the principles of sustainability and pro-environmental behavioral patterns among the employees, which advances the concept that the cultural and behavioral alignment is crucial in the realization of substantial sustainability results. Besides the performance results, the study offers strong evidence that green talent management can greatly help decrease the intention to turnover the employees. This is of a high concern especially to software industry in Pakistan where there is a high mobility of employees in addition to high competition among talented professionals. In line with the Human Capital Theory, the findings also suggest that employees tend to stay longer in an organization that invests in their growth and align their organizational practices with their personal values especially those that have to do with sustainability. Through environmental responsibility as part of management of talent, organizations develop a feeling of purpose, commitment and attachment to the organization in the long run, thus reducing the risks of turnover. One of the main contributions of the study is the confirmation of the modulating nature of HRM investments. The results indicate that the turnover alleviating impacts of both green hard and green soft talent management are more pronounced whereby organizations invest heavily in training, growth and human capital support. This underscores the fact that green management talent practices will never be complete unless they are supported by physical organizational investments. These findings support previous findings that HRM investments are used to enhance the efficacy of strategic HR practices because it indicates the long-term organizational commitment to employees. Therefore, the HRM investments are an imperative facilitative mechanism that can turn the green talent management into a sustainable retention strategy. This study further proves that the observed relationships are not just due to favorable work environment or organizational resource endowments through its ability to control work environment and availability of resources.

The results highlight the fact that green talent management has a significant, independent and substantial effect on both sustainability and

turnover. This enhances the internal validity of the study and highlights the strategic applicability of green HR practices despite the possible scarcity of resources in many developing economies as it is usually the case. To sum up, the present research has revealed strong arguments that green talent management can be viewed as a viable strategic and sustainable route that software companies in Pakistan are taking to both improve business performance and retain their human resources. Talent management practices can effectively develop resilient, committed and sustainability-focused workforces by incorporating environmental sustainability in both the technical and behavioral aspects of talent management as well as by investing appropriate amounts of HRM resources in these practices. The results are not only useful in developing the Green HRM theory but also provide the practitioners with a clear outline of the direction to take to maintain the competitiveness, sustainability, and retention of employees in the fast-changing knowledge-based sectors.

9.   LIMITATIONS

This study is limited in a number of ways although it made its contributions. On the one hand, the cross-sectional design does not allow to develop causal relationships between the study variables. Though the hypotheses were confirmed, longitudinal designs would be able to give more convincing reasons of causality (Kline, 2016; Hair et al., 2022). Second, the use of self-reported survey information also creates the risk of common method bias, even though procedural and statistical controls were used (Podsakoff et al., 2012). Third, the study was exclusively focused on software industry in Pakistan which can inhibit the extrapolation of the results to other industries or countries. Lastly, the research is able to control the conditions of the work environment and availability of resources but other potentially relevant variables, including a leadership style or an institutional pressure, were not analyzed.

10.   FUTURE RESEARCH DIRECTIONS

This research can be expanded in a number of ways in future studies. To begin with, scholars are advised to use longitudinal or mixed-method designs to fulfil dynamic impacts of green talent management on sustainability and turnover outcomes within a timeframe (Hair et al., 2022). Second, cross-industrial or cross-national research may shed new light on the contextual difference in the developed and developing economies (Aboramadan and Karatepe, 2023). Third, the prospective studies can investigate more mediating or moderating variables, including green leadership, psychological

empowerment, or organizational identification to better clarify the role of green talent management on employee behavior (Luu, 2022; Zaid et al., 2024). Lastly, the application of objective sustainability and performance measures in addition to perceptual ones would enhance empirical rigor and practical applicability even more.

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