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# Green project management practices, green knowledge acquisition and sustainable competitive advantage: **Empirical evidence**

## Abstract

**Purpose** – *This study envisages the impact of green project management practices (GPM) on sustainable competitive advantage (SCA). Moreover, the study also accessed the mediating role of green knowledge acquisition (GKA) as a mechanism between GPM and SCA.*

**Design/methodology/approach** – *Using a quantitative field survey, data were collected from the multi-sector manufacturing enterprises (n = 265) in Pakistan. The measurement and structural model were tested through Analysis of Moment Structure (AMOS) by conducting a covariance structure analysis.*

**Findings** – *The findings suggest that GPM practices are positively related to SCA. In addition to this direct effect, GKA play a significant role in explaining the associations between GPM practices and SCA. Our findings bring essential insights for the enterprises, policymakers, practitioners, and project managers to promote GPM practices for low-carbon projects to achieve SCA.*

**Research limitations/implications** – *The data used in this study is cross-sectional in nature. The geographic location is limited to firms in Pakistan while well-validated subjective measures are used to make the survey more convenient for participants.*

**Practical implications** – *The practitioners in general while project managers in particular are recommended to implement GPM practices and GKA to achieve high performance of SCA.*

**Originality/value** – *This is one of the first studies to examine GPM practices and its effect on SCA directly and via GKA in a single model.*

**Keywords** *Green project management; Green knowledge acquisition; Sustainable competitive advantage; Covariance structure analysis*

**Paper type** *Research paper*

## 1. Introduction

Environmental sustainability is recently acknowledged as essential for reducing the detrimental effects of industrial waste, traditional products, and hazards produced by firms (Chiappetta Jabbour, 2015; Chiappetta Jabbour et al., 2015; 2020; Latan et al., 2020; Li et al., 2020). Environmental sustainability “is the ability to maintain things or qualities that are valued in the physical environment” (Sutton, 2004, p. 1). According to the latest developments in environmental sustainability, a growing number of firms incorporate environmental social, and governance (ESG) activities into their management practices to enhance environmental and corporate sustainability. ESG is an analytical framework which expands a firm’s strategy to sustainability and beyond environmental issues (Li et al., 2021). This framework includes identification, assessment and management of sustainability-related risks and opportunities. ESG strategy not only helps stakeholders to understand a firm environmental aspect (climate change, greenhouse gas emissions, energy efficiency), social aspect (equity, diversity, inclusion), and governance aspect (management structure, executive compensation, corruption) but it also offers higher returns on the investments. Moreover, recent studies suggest that environmentally friendly and ESG-linked products and services are primarily placed on the first order of customers’ preferences (Amui et al., 2017). As a result, several organizations have embraced ESG criteria into their long-term strategy, which is vital for Sustainable Development Goals (SDGs), sustainable corporate success, economic performance, and competitive advantage (Ali, 2021; Chiappetta Jabbour, 2013; Shahzad et al., 2020).

Silvius and Schipper (2016) on the other hand indicated that organizations emphasis vehemently on the need for project managers to embrace sustainability in managing project as their professional responsibility. As sustainability is perceived to be the necessary ingredient for all type of businesses to understand the environmental consequences of projects and their

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3 support system such as designing, operating, maintenance and eventual disposal. Since,  
4 environmental sustainability is considered one of the most relevant contemporary challenges  
5 faced by firms (Yusliza et al., 2020). This importance and pressure to adopt environmental  
6 sustainability has been evidenced since 1972 with the United Nations conference for the  
7 environment that occurred in Stockholm, and the global problems of environmental  
8 sustainability have been part of the political agendas of most countries (Imran et al., 2021).  
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17 In the field of project management, “sustainability” is particularly essential due to  
18 economic uncertainties, project complexities, cost overruns, pollution prevention, clean  
19 production process and clean technology (Khalifeh et al., 2020; Yong et al., 2020). Though in  
20 project-oriented organizations, the green project management (GPM) practices have become  
21 increasingly evident and the need to develop specific practices to make them innovative and  
22 competitive (Silvius & Schipper, 2014; Silvius et al., 2017) is yet to explore. GPM practices  
23 refer to the environment-friendly processes or procedures involved in green projects (e.g.,  
24 green manufacturing projects) that enable decision-making by considering its influence to  
25 impact the environment (Silvius et al., 2017). Besides, GPM works with the organization’s  
26 environmental management system by integrating “green thinking” during the project. It  
27 involves the handling and execution, strategic objectives, alignment of the project resources,  
28 integrated change processes, responsibilities, and authorities in daily project’s activities  
29 (Maltzman & Shirley, 2010) which remains poorly understood (Mavi & Standing, 2018;  
30 Silvius & Schipper, 2014).  
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Effective management, which corresponds to GPM practices, is a favorable predictor of project performance (Dumrak et al., 2017). Furthermore, performance is primarily related to sustainable competitive advantage (SCA) as a significant factor in perceiving goods and services' value (Ali, 2021; Barney et al., 2021b; Powell, 2001). The competitive advantage is perceived to be a beneficial factor that expands the revenues from investments (Ali, 2021;

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3 Khan, Yang, & Waheed, 2019). Several firms follow project management methodology to  
4 outperform their rivals (Joslin & Müller, 2015; Kerzner, 2019) to ensure the completion of  
5 projects on time (Millhollan & Kaarst-Brown, 2016; Pace, 2019). Chen et al. (2016) emphasize  
6 that companies embrace project management if they show value creation. Given the challenge  
7 of aligning the performance of projects with the creation of value, it can occur through new  
8 knowledge, creativity, and practices, bringing benefits to society to boost economic results  
9 (Severo et al., 2020) as well as building market share and competitive advantage (Leal-  
10 Rodríguez et al., 2018).

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22 Due to global competitiveness, GPM practices can be crucial to run more green projects  
23 and finish them by developing more sustainable practices, facilitating product recovery, cost  
24 minimization, saving energy, saving water, and reducing carbon emissions. Despite the  
25 importance, existing literature has investigated limited topics within the scope of GPM  
26 practices such as critical success factors (Li et al., 2011) challenges and solutions (Hawang &  
27 Tan, 2012) for implementing GPM practices but little is known on how GPM practices can  
28 influence and impact green knowledge acquisition (GKA) for SCA. Moreover, only a few  
29 qualitative studies (e.g., Al-Qassab et al., 2019; Armenia et al., 2019; Hand et al., 2015) have  
30 explored the concept of GPM practices concerning green construction and sustainable  
31 buildings, but GPM practices' empirical investigation has not been identified in the prior  
32 literature to the best of our knowledge. Therefore, this study aims to investigate the relationship  
33 between GPM practices and SCA as they are an essential ingredient for awarding SCA.

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51 In general, theories and research have discovered that acquiring green knowledge is of  
52 the critical processes by which organizations can become sustainable (Martínez-Ros &  
53 Kunapatarawong, 2019). The primary purpose of GKA is to obtain green knowledge. It is  
54 critical for organizations to obtain several types of knowledge (Bloodgood, 2019), while green  
55 knowledge refers to advances in green technologies and green needs (Chen, 2008). We assert  
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3 that knowledge resources are one of the organizations' fundamental assets (Barney 1991;  
4 Lavié, 2006) to remain competitive. However, despite its fundamental relevance at macro level,  
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6 the role of GKA in fostering SCA has largely been ignored in the KM literature. Moreover, the  
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8 economies are shifting from traditional economy structure to knowledge-based economy even  
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10 digital economies is an extension of knowledge economy (Di Vaio, Palladino, Pezzi, & Kalisz,  
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12 2021). Therefore, not limited to GPM practices—SCA nexus, there is a need of further  
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14 exploration to identify mechanism between GPM practices—SCA (Khater, 2021). In light of  
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16 the practical relevance and academic calls for research on GPM practices, we propose GKA as  
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18 an important knowledge channel between GPM practices—SCA. Taken together, the study  
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20 aims to address these two questions, building on the established gaps and loopholes in the  
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22 literature:  
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- 28 • RQ1: Do GPM practices affect SCA?
- 29 • RQ2: Is the relationship between GPM practices and SCA mediated by green  
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31 knowledge acquisition?  
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35 This study makes important contributions to the existing literature. First, this is one of  
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37 the first studies exploring GPM practices theoretically and empirically in the context of project-  
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39 oriented organizations (Malik & Ali, 2022; Khater, 2021). Second, along with GPM practices,  
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41 this study further assesses the mediating role of GKA which has not been tested in the prior  
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43 literature. Moreover, the study adopts the theoretical lens of resource-based view (RBV) to  
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45 understand how firms create and retain strategic resources to achieve and sustain competitive  
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47 advantage (Singh et al., 2020; Tu & Wu, 2021).  
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51 Section 2 summarizes the review of the literature and proposes the hypotheses. Section  
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53 3 describes the method. Section 4 reports the analyses and findings of the study. Finally,  
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55 Section 5 presents the discussion and conclusion and provides implications and future research  
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57 directions.  
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## 2. Theoretical foundations and conceptual framework

### 2.1. Resource-based view of firms

The study draws upon the RBV (Barney, 1991; Barney et al., 2021b) of firm as the focal point of this theory is company's resources and assets. Both knowledge management (KM) and environmental management research have utilized RBV of a firm extensively to highlight divergent perspectives on strategy creation as a significant driver of organizational success (Andersén, 2021; Hsieh et al., 2019; Wei & Sun, 2021; Wu & Li, 2020). RBV manages with the complexity behind the firm's organization in terms of striving for the maximum effort to construct, maintain and make the most of the resources and capacities that a company has that represent the key determinants of the firm's business. Similarly, project-oriented organization is one of a kind and that it should constantly learn through its working processes, skills, knowledge, and technologies and make them distinctive in its business environment. In this vein, the concept of "competitive advantage" is explained as the company's most important weapon in taking over the market it has set its goal on. However, this concept cannot be used by the opponent company. Barney and Hesterly (2006) explained that when the opponent company is not able to implement the same methods, the competitive advantage is set to be successful.

A substantial expansion of the RBV, the natural RBV (NRBV) considers the ecological effect of organizational resources and the processes resulting from this resource base. It is based on the idea that a firm's competitiveness depends on how it interacts with the natural environment (Zhang et al., 2020; Zhou et al., 2020). Numerous studies have connected the knowledge-based view (KBV), which highlights intellectual capital as an unrivalled resource and key driver of productive growth, with the theoretical development of the RBV (Badghish et al., 2022; Tu & Wu, 2021). In this vein, Penrose and Pitelis (2002) have distinguished between tangible (materials, equipment, etc) and intangible resources (employees, staff, etc).

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3 Without services, the exploitation of these resources, tangible and intangible, would not be  
4 possible. They described services as a process in which way assets are utilized. Along these  
5 lines, resources can be seen as a collection of services. This collection of services could be  
6 extended by expanding the expertise and capabilities of organizations in more precise way to  
7 improve knowledge. Theorizing on RBV, GPM practices are conceptualized as organizational  
8 resources for planning, monitoring, management, and human resource systems in enterprises.

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10 Similarly, GPM practices are the abilities and resources which are valuable, rare, inimitable,  
11 and non-substitutable (VRIN) have a perspective to produce sustained competitive advantage  
12 for a company (Campbell et al., 2012). We posit that not resources by themselves are able to  
13 produce sustained competitive advantage, but the combination of both, resources, and abilities,  
14 needs to contain these attributes with a specific end goal to produce sustained competitive  
15 advantage. Based on this, (Behl et al., 2022) showed that it is better for a firm to internationalize  
16 in sequential order taking into consideration the resources of a firm. In other words, a firm  
17 could try to create valuable resources and abilities in one market (e.g., closest to the home  
18 country) and only then enter the new market after it has gained enough experience and  
19 knowledge with their resources in the previously entered market.

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21 RBV lies on the principle that the main advantage for a company is to find the most  
22 efficient and effective way to move resources within and outside the organization without  
23 losing any value of the resources. Resource value can be described as the level of participation  
24 in a company's competitive advantage. In other words, the more resource participates in the  
25 creation of the company's competitive advantage the more valuable it is. Similarly, KBV argues  
26 that the primary duty of an organization is to synthesize the human capital resources. Human  
27 capital resources are the specialized knowledge and expertise that exists among its workers and  
28 throughout its network of business associates, which combined represent its distinctive  
29 organizational capabilities (Shahzad et al., 2020; Yong et al., 2019). In this vein, firm's human  
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capital resources (e.g., knowledge acquisition) plays a crucial role (Murayama, 2022).

Consistently, firm's GKA depends on its GPM practices and ability to acquire and absorb specialized knowledge resources that might be able to develop assets inside the organization to enhance SCA. Conclusively, the study asserts that GPM practices serves as the VRIN organizational resources for the project-oriented organizations to facilitate them in achieving and sustaining competitive advantage through GKA.

## 2.2. *Green project management practices*

GPM practices are defined as the environment-friendly processes to enable green-conscious decision-making at various stages of the project (Silvius et al., 2017). According to Carvalho and Rabechini Junior (2015) GPM can either be viewed from internal perspective or from external perspective. The authors noted that the internal perspective is link to the project life cycle, the knowledge areas and the process groups whiles the external perspective is linked to social and environmental impact of the project in a broader perspective. This study mainly focuses on the external perspective of GPM practices. In a study, Marcelino-Sádaba et al. (2015) observed that projects are the ideal instrument for change and the necessary change that we require towards sustainability will be boosted by applying the project management discipline to sustainability. Projects and their management are recognized as “a way to sustainability” (Huemann & Silvius, 2017). Doubtlessly, greening should be introduced at an organization level and yet it is still an under-developed research area (Khater, 2021).

Greening in PM can be viewed from different angles. Consistently, starting and maintaining successful environmental sustainability demands a high level of GPM practices, because these practices involve how firms collect information from external sources and use new knowledge gained via collaboration with project stakeholders (Silvius, 2021). The RBV's notion of firms having higher GPM and GKA resources as being more likely to generate green

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3 processes and sustainable goods (Ashrafi et al.,2019) for gaining a competitive edge. However,  
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5 environmental issues could be another challenge.  
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9 To combat environmental issues and achieve a competitive advantage, some research  
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11 studies have recommended the application of eco-design methods (Brones & Carvalho, 2015;  
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13 Cicconi, 2020) and project life cycle analysis (Silvius & de Graaf, 2019) as support for  
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15 incorporating environmental sustainability into project management decisions. In order to  
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17 achieve these goals, the International Federation of Consulting Engineers (FIDIC) has been  
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19 creating tools for engineers and other professionals working at project-based organisations.  
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21 These tools will enable them to significantly contribute to the advancement of society's  
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23 sustainability. FIDIC's objective is to represent and support the interests of technology-based  
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25 service-providing firms and engineers. Sustainability is an important highlight in FIDIC's new  
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27 strategic plan for 2020-2024 (FIDIC, 2022). This plan focuses on laws and regulations for  
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29 protecting project's site, and design proactive programs to reduce carbon emissions during  
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31 projects. Consequently, FIDIC supports the advancement of sustainability in projects through  
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33 the development and implementation of new and more sustainable technologies, systems,  
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35 policies, and programs.  
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### 42 2.3. Green knowledge acquisition

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44 Environmental sustainability and project management issues have been a battle where  
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46 numerous studies have been conducted. However, not much effort has been made in linking  
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48 the two together. Some initiative taking only addresses the themes where sustainability  
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50 practices in organizations are assessed on broader based without addressing specific  
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52 organizational functions for collecting environment related information to resolve ecological  
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54 concerns (Shahzad et al., 2021). It is important to remember the gap in the management level  
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56 of organizations regarding the incorporation of sustainability aspects in organizational  
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3 processes, arguing the need for the incorporation of solution driven range of information that  
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5 can be called as green information (Benabdellah et al., 2021). More specifically, project driven  
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7 organizations require this green information that can be about innovation or green technologies  
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9 (Singh et al., 2022). Drawing on KBV, the study premised GKA as acquiring green information  
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11 to facilitate GPM practices for achieving SCA (Biscotti et al., 2018).  
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15 Accordingly, the capability of an organization to acquire green knowledge may be  
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17 referred as its ability to build the competence to create green business insights from multiple  
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19 information sources that internal employees can utilize for strategic decision-making.  
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21 However, organizations are continuously failing to extract value for business to maintain their  
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23 competitive position (Shahzad et al., 2020). Thus, GKA capabilities widen the scope of PM  
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25 processes for encompassing environmental sustainability to harness strategic potential of green  
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27 information.  
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#### 31 32 *2.4. Sustainable competitive advantage*

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34 A competitive advantage from a value resource can be sustained as long as the number  
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36 of firms with the same resource does not exceed the number of firms required to generate  
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38 perfect competition dynamics within an industry (Ali, 2021). It is critical that all employees in  
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40 a firm, no matter how big or small, have a shared knowledge of what "practice" implies and  
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42 are capable of putting that understanding into action. It is possible to view competitive strategy  
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44 from the standpoint of practice, just like other company activities and procedures. Once the  
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46 market sector has been determined, competitive strategy usually revolves around gaining  
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48 market advantage through various practices or might be differentiation strategies (Salimath &  
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50 Philip, 2020). Sustainable practices and GKA can all be used to differentiate a product or  
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52 service from the competition.  
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57 Differentiation can be achieved in conjunction with GPM practices, and the two  
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59 techniques are not necessarily incompatible (Malik & Ali, 2022). So, the RBV is composed of  
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3 two main parts: the company's resources and the company's ability quickly change its  
4 competencies (Nisar et al., 2021). In addition to VRIN, the adoption of sustainable practices is  
5 crucial, as only firms with adequate financial resources and management capabilities can  
6 imitate proactive environmental strategies that have been effective for other firms (Zhang et  
7 al., 2020). Moreover, SDG's can aid companies to integrate sustainability in their business  
8 models for keeping an eye on business opportunities in a rapidly changing environment and  
9 making a robust business model for SCA. This applies to intangible resources pertaining to  
10 sustainability as well; for example, a reputation for GPM practices and GKA could be  
11 considered as resources that yields a SCA.  
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## 25 *2.5. Related empirical literature and research hypothesis*

### 26 *2.5.1. GPM practices and SCA*

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29 With global competition, PM practices are gaining considerable attention (Griffin-EL,  
30 2015; Trantopoulos et al., 2017) for improving organizational efficiency and quality (Aga et  
31 al., 2016). The project management institute (PMI) has developed a set of acceptable practices  
32 and methodology for efficient PM implementation (de Guimarães et al., 2017). Identifying  
33 these practices is essential for sustaining the competitive advantage (Malik & Ali, 2022) and  
34 may improve organizations' performance in projects among the project's portfolios. For this  
35 purpose, the alignment of projects with project management practices to the customer needs  
36 gives a more rigorous portfolio success (PMI, 2017) as alignment gives a clear picture to  
37 manage the project barriers related to cost, scope and quality (Hoffman et al., 2020). This study  
38 extends the scope of these PM practices to GPM practices. Green project management is  
39 defined as “a way to ingrain green think” into every PM process (Maltzman & Shirley 2010).  
40 This study argues that for managing green projects, GPM practices help organizations to align  
41 with their strategy and to adopt a greater focus on environmental protection. In this way, project  
42 managers would pay attention to GPM processes and look for ways to improve them to  
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3 minimize project-related costs without compromising the quality. Overcoming these  
4 challenges will give an organization a competitive edge in the form of re-emerging economic  
5 growth.  
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10 This study hypothesizes that GPM practices are positively related to SCA. Besanko et  
11 al. (2000) characterize competitive advantage as a higher rate of the firm's economic profit in  
12 the marketplace over their competitors' typical rate. Barney and Hesterly (2006) define  
13 competitive advantage as a firm's ability to achieve higher economic worth than its competitors.  
14 Moreover, competitive advantage is measured by a firm's achievement in using its  
15 organizational resources to meet its customers' demands compared to its competitors (Erena et  
16 al., 2022). The main focus of organizational leaders is attaining a competitive advantage as it  
17 has become the most challenging task for this century (Rehman et al., 2021). Since over the  
18 past 20 years, scholars and practitioners focus on the factors and resources that can lead to  
19 SCA.  
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33 It is noteworthy that PM practices vary from project to project (Kerzner, 2001).  
34 However, projects generally consist of resembling activities and deliverables (Kerzner, 2022).  
35 Regardless of project's nature, conducting projects is the organization's way of generating the  
36 long-term investment goals of a company, which in its turn contributes to sustainability in a  
37 long-term perspective including SDGs (Magano et al., 2021). Recently, Banihashemi et al.  
38 (2017) demonstrate the first quantification in the form of a model for integrating sustainability  
39 at each stage of PM practices. Moreover, these practices were further studied by (Stingl &  
40 Geraldi, 2017) to investigate behavioural decision-making and its application in projects, which  
41 provide a basis for systematic cognitive mapping and fundamental theories to identify the  
42 missing gaps and essential links in decision making. Similarly, Chou et al. (2017) used an  
43 integrated approach to determine the priority and interrelationship structure of criteria in  
44 green PM. Their findings revealed an identification of twenty-four criteria and six dimensions  
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3 of green practices for environmental sustainability and supply chain management. More  
4 recently, Al Qassab et al. (2019) conducted an exploratory study by surveying 30 project  
5 managers to identify and evaluate the project manager's skills that are required for the  
6 implementation of GPM practices. Since GPM skills are important for the project managers to  
7 be environmentally aware and keep the natural environment safe from hazards. Accordingly,  
8 we posit that through GPM practices, firms will be able to transform and integrate new  
9 thoughts, ideas and solutions for decision making by taking into account the environmental  
10 impact—if any. Consequently, these decisions will help firms be more productive and efficient  
11 to sustain their competitive advantage. Based on the above arguments, this study hypothesizes  
12 as follows:  
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26 **Hypothesis 1.** *GPM practices are positively related to SCA.*  
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#### 28 2.5.2. *The mediating role of green knowledge acquisition (GKA)* 29

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31 The knowledge related to a firm's environmental protection is referred to as green  
32 knowledge acquisition (Chen et al., 2008). According to the RBV, knowledge has to be used  
33 strategically with other resources and skills to give a competitive edge (Barney, 1991; Tu &  
34 Wu, 2021; Zhou et al., 2020). In this vein, organizations identify their critical resources through  
35 green knowledge, a firm's essential resource to achieve SCA. Besides, the organizations must  
36 collect and distribute knowledge to achieve SCA and meet environmental regulations (Martins  
37 et al., 2019). As a vital resource, to achieve its benefits efficiently, knowledge must be handled  
38 and acquired effectively. This study proposes that GPM practices indirectly influences SCA  
39 via GKA. In other words, a firm's competitive position may depend upon its environmental  
40 knowledge along with various environmental technological resources to obtain a competitive  
41 advantage. In a PM context, knowledge plays a fundamental role. GPM practices provide to  
42 firm's new knowledge that can be acquired from PM methodology, technology and market  
43 (Malik & Ali, 2022). Only with GPM practices organizations effectively identify green  
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3 knowledge, find the best approaches to acquire knowledge and further effectively integrate that  
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5 green knowledge to be more efficient; thus, organizations move towards SCA.  
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8 Project-based organizations may acquire green knowledge as the principal capital for  
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10 performing their specialized roles. Large-scale green projects are complex in this vein, having  
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12 a longer duration, high costs, technological uncertainty, highly diverse contractors and multiple  
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14 stakeholders, and versatile project teams (Mok et al., 2018). These projects need to acquire  
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16 green knowledge to disseminate to encourage learning at the organizational level throughout  
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18 the project. Therefore, GPM practices can be anticipated to boost GKA to adopt  
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20 communication systems, project-oriented culture, faster and better decision making, quicker  
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22 problem solving and increased innovation. This way, firms will become more knowledgeable  
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24 about green practices provided in the sector. Several studies also ascertained that reducing  
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26 environmental pollution and toxins was accomplished by acquiring knowledge more than  
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28 integrating and using physical resources (e.g., land or materials) (Borah et al., 2021; Love et  
29  
30 al., 2005). In this way, GPM practices will contribute to SCA through GKA. Based on the  
31  
32 above discussion, the following hypothesis is proposed:  
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37 **Hypothesis 2:** *Green knowledge acquisition mediates the relationship between GPM practices*  
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39 *and SCA.*  
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43 \*\*\*\*\* please insert Figure 1 about here\*\*\*\*\*  
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### 46 **3. Method**

#### 47 *3.1. Sample and procedures*

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49 In this study, we use a quantitative-based approach to analyze the empirical data  
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51 collected through the survey method to test our proposed theoretical model. Given that research  
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53 in the management and strategy domains generally employs a self-reporting technique,  
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55 especially when data for the variables being tested not archived in nature to measure focal  
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3 constructs. In this regard, the majority of the existing studies related to GPM practices and  
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GKA faced these limitations as well as the scarcity of empirical findings. Therefore, our current study can be considered as one of the preliminary empirical study to examine the relationship between GPM practices on sustainable competitive advantage through GKA using primary data.

In selecting the sample for this study, we used the enterprises with PM approaches in the manufacturing industries. A small or medium incorporated enterprise is described as having up to 250 employees, with a paid-up capital of up to 25 million rupees (1 USD = 160.23 PKR) and annual sales up to 250 million rupees (SMEDA, 2007). To ensure the precise sample, we added screening questions in the first section: (1) if the enterprise considers itself as project-driven, (2) If GPM practices are used in these enterprises for environmental sustainability.

The present study included the enterprises from the manufacturing industries related to equipment, textile, paper, pharmaceutical, sports goods, fertilizer, tobacco and chemical. These enterprises are listed with the Securities Exchange Commission of Pakistan and Pakistan Stock Exchange, with ISO 9001 and ISO 14001. We selected these enterprises for the following reasons: First, there are almost 3.3 million enterprises in Pakistan, making up 25% of manufacturing exports (SMEDA, 2020). Moreover, in most selected enterprises, green PM was used for more than six years and was profitable for the company by more than 70%. Manufacturing-based enterprises are heavily reliant on PM practices (Pollack & Adler, 2016) and professional knowledge for quickly adapting to changes and tracking their market participation and profit (Mohsenabad & Azadehdel, 2016). Second, these enterprises are technology-intensive because they consider new ideas by identifying, creating, sharing and utilizing scientific and technological knowledge to fulfil customer demands by developing new products and services (Razzaq et al., 2019). Finally, developing and implementing KM plans



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3 improves manufacturing enterprises' overall effectiveness by managing business and  
4 management activities.  
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8 This study employed a non-probability snowball sampling technique suggested by  
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10 Bryman and Bell (2011). This sampling technique ensures a faster response rate by using  
11 referrals and achieving a large sample size (Shahzad et al., 2020). The data were collected from  
12 manufacturing and technical project managers working in manufacturing enterprises across  
13 Pakistan. The study's purpose and objectives were shared with the respondents and indicating  
14 that the participation is voluntary. Questionnaires were distributed using self-administered field  
15 surveys following the previous studies in a similar context (Khan et al., 2019). This field  
16 research approach, although time-intensive and costly to maintain, is highly effective in regards  
17 to developing economies like Pakistan due to the limited availability of online survey methods  
18 and unwillingness on the part of local firms to respond to the study (Amankwah-Amoah et al.,  
19 2019; Khan et al., 2020; Lin et al., 2021). In addition, a cover letter ensured strict confidentiality  
20 and anonymity of the responses. A self-addressed unmarked envelope was included to deposit  
21 their responses and instructed them to place the envelope's completed survey.  
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38 Four hundred and twenty-nine questionnaires were circulated among the selected  
39 enterprises, out of which 270 responses were received with a response rate of 62.94%. Due to  
40 missing values, five responses were discarded. Taking these missing values into account, we  
41 found our data to be missing completely at random (MCAR). Thereby, removing the missing  
42 values did not affect our sample. The final sample size achieved comprised 265 enterprises  
43 with a response rate of 61.77%, which is in line with the response rate for studies in the field  
44 of management and organization (Dillman et al., 2014; Holtom et al., 2022). Following the  
45 sample size recommendation for performing covariance structure analysis (Byrne, 2016; Kline,  
46 2016; Whittaker & Schumacker, 2022), our study met a minimum sample of 200-250 cases  
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3 required to estimate the common factor model. Table 2 depicts the demographics details of the  
4 enterprises and respondents.  
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8 \*\*\*\*\* please insert Table 1 about here\*\*\*\*\*  
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10 \*\*\*\*\* please insert Table 2 about here\*\*\*\*\*  
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### 12 13 3.2. Measures

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15 Measurement is a central part of quantitative research (Pedhazur & Schmelkin, 1991).  
16 We adopted items from previous studies to measure each variable, considering these items have  
17 been validated and have gone through the stages of scale development (DeVellis, 2022). In this  
18 study, the respondents were asked to express their opinions with the help of a five-point Likert  
19 scale where the highest from “strongly agree” refers to “5”, and lowest at “strongly disagree”  
20 refers to “1” regarding the measurement of items. The details of the measurement items used  
21 for the questionnaire are provided in Table 3. Our study focuses explicitly on GPM practices  
22 related to methodology and systems in the present research context. We adopted the pre-  
23 established scale consisting of 5 items from previous studies (Kerzner, 2001; de Guimaraes et  
24 al., 2018) and modified it in the green PM context (see Table 3). To measure the GKA, a 3-  
25 item measurement design was adopted from Yli-Renko et al. (2001) and Presutti et al. (2007).  
26 Finally, sustainable competitive advantage was measured using a 6-item measurement scale  
27 (Ali, 2021; de Guimarães et al., 2018).  
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### 46 3.3. Control variables

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48 Following the recommendations suggested by Becker (2005) and Becker et al. (2016),  
49 we performed several One-way Analyses of Variance (ANOVAs) to test if there were  
50 significant differences in the outcomes across gender, managerial level, organizational type,  
51 qualification, income levels, project duration and marital status. The results of ANOVA  
52 revealed that there were no significant differences in the outcome variables across these factors.  
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3 Therefore, to preserve the statistical power and prevent possible side effects such as  
4 uninterpretable parameter estimates or erroneous inferences, we excluded the control variables  
5 from our primary analyses. In addition, according to Bernerth and Aguinis (2016), Li (2021)  
6 and Rights et al. (2020), the use of control variables is only justified when there is sufficient  
7 theoretical support, not based on assumptions or trends in scientific research. Misuse of control  
8 variables can change the results of the findings, conclusions and lead to type I or type II errors.  
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#### 18 3.4. *Non-response bias and common method variance (CMV)*

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20 We examined several biases might have interfered with the results of our survey. First,  
21 we examined non-response bias by comparing early and late responders. The results of the *t*-  
22 test indicated there was no difference ( $p > 0.05$ ) between the two sample groups (see Table 1).  
23 To strengthen this finding, we compared those who initially refused to participate in the study  
24 with those who never declined (Fulton, 2018). Again, we found no difference between the two  
25 groups, which can be concluded that non-response bias did not occur in our case (Vogel &  
26 Jacobsen, 2021).  
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36 Furthermore, we examined common method variance (CMV), which often threatens  
37 the findings when the same respondent answers questions for a set of variables. Previously, we  
38 applied several procedures to minimize this bias. In this study, we reduce this bias by randomly  
39 ordering the items for each variable. We also guarantee the anonymity of the respondents. We  
40 tested this bias through the marker variable technique (Bozionelos & Simmering, 2022;  
41 Simmering et al., 2015) and found that the marker model generated through confirmatory factor  
42 analysis (CFA) resulted in a poor goodness of fit (GoF) and also did not correlate with the main  
43 variables ( $r = 0.093$ ) in the model (see Table 1). Based on these results, we conclude that CMV  
44 is not a threat that interferes with our results.  
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#### 58 3.5. *Data analysis*

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3 We employ covariance structure analysis (CSA) to test the proposed model and confirm  
4 the testing of the hypotheses. Our considerations are as follows. First, CSA is the right approach  
5 to use when the model being tested is a common factor model, not a composite model. That is,  
6 our model is built on the basis of theory and previous studies, and aims to examine causal  
7 relationships between latent variables (Byrne, 2016; Kline, 2016; Whittaker & Schumacker,  
8 2022). Second, CSA is a robust approach since it takes into account measurement errors and  
9 produces unbiased estimates (Diamantopoulos & Siguaaw, 2000). In addition, CSA produces  
10 various goodness of fit indices (GoF) including ‘absolute’, ‘incremental’ and ‘parsimonious’  
11 to test the fit between the model and the data (Byrne, 2016). Finally, CSA has been widely  
12 recognized and useful for explanatory research in social science fields including KM.  
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26 We used the Maximum Likelihood (ML) estimator, considering that our sample size ( $n$   
27 = 265) satisfies the rule of thumb of the sample size recommended by SEM experts to use this  
28 method. With our sample size, our model will avoid negative variance (or so-called Heywood  
29 cases), where our sample size is larger than the number of parameters in the model. We also  
30 ensure that our models are properly specified and identifiable with degrees of freedom equal  
31 to or greater than 1 (Whittaker & Schumacker, 2022).  
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40 Overall, we report the results of CSA through a two-step approach (Boomsma et al.,  
41 2014; Zhang et al., 2021). First, we report the results of the measurement model for the validity  
42 and reliability of the items. CFA was used to assess the measurement model and also produce  
43 the goodness of fit (GoF) of the CFA model. Second, we report the results of the structural  
44 model for several core metrics such as coefficient of determination ( $R^2$ ), effect size ( $f^2$ ),  
45 variance inflation factor (VIF), GoF indices for the overall model and testing the hypotheses  
46 by considering the critical ratio (CR) at significance 5% (one-tailed test). Finally, we added  
47 several robustness tests to strengthen our main findings and ensure that our results are free from  
48 estimation bias.  
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## 4. Results

We used the Analysis of Moment Structure (AMOS) version 28.0 (Arbuckle, 2021) to execute the CSA. According to Byrne (2016), AMOS is preferred because it supports a graphical user interface (GUI) and it is easy to use. We examined the results of the assessment of normality through the values of skewness and kurtosis. Given that the ML estimator assumes the residual error should be normally distributed, we find that our data fulfills this assumption with CR values  $< 10$  for kurtosis and CR values  $> 3$  for skewness (Byrne, 2016; Kline, 2016). However, considering that the assessment of normality in AMOS is susceptible to effects of sample size, we added the Mardia's multivariate normality test as a complement. We did not find significant skewness or kurtosis values for the Mardia's multivariate test with  $p$  values = 0.236 and 0.548  $> 0.05$ , respectively. Thus, we conclude that the normality assumption is met. Furthermore, we check for outliers by calculating the z-score values for each case. We found z-score values  $< 2.58$  for all cases, indicating no outliers in our dataset (Kline, 2016).

We report descriptive statistics through the mean and standard deviation values of all the items (in Table 3), and calculate correlations between variables (in Table 4). Based on the guidelines from Cox and Holcomb (2022), we found that the mean and standard deviation of the variables do not exceed the maximum values and the sign of the correlation is not reversed. Even farther, we did not find a correlation between two variables greater than 0.70 for all pairs, which indicates that there is no collinearity problem. We corroborate this evidence by calculated the variance inflation factor (VIF) for each predictor variable and found a VIF value  $< 3.3$ , which satisfies the rule of thumb threshold, indicating no collinearity problem (Kalnins, 2018).

### 4.1. Measurement model evaluation

We performed CFA to assess the measurement model (Nye, 2022). First, Cronbach's alpha ( $\alpha$ ) and composite reliability ( $\rho_c$ ) were used to assess the reliability of the constructs, with

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3 a recommended value greater than 0.70 (Garson, 2015; Nunnally & Bernstein, 1994). Table 3  
4 shows that the values for  $\alpha$  ranged from 0.84 to 0.86, and  $\rho_c$  ranged from 0.84 to 0.87, which  
5 met the recommended threshold. Second, convergent validity was examined through the  
6 average variance extracted (AVE) and standardized factor loading (SFL). The AVE values  
7 must be greater than 0.50, and the SFL values must be higher than 0.708, although the value of  
8 0.60 is still acceptable to strengthen the content validity (Bandalos and Finney, 2019; Garson,  
9 2015; Zhang et al., 2021). In this study, these values are adequate and satisfactory (see Table  
10 3).

11  
12 Hereinafter, the discriminant validity was evaluated using two approaches—the  
13 heterotrait-monotrait ratio (HTMT) and HTMT2 (Henseler, 2021). Both approaches propose a  
14 cut-off value of less than 0.85. The values of HTMT and HTMT2 obtained under the diagonal  
15 line in Table 4 indicate that discriminant validity was met in this study. We also calculated the  
16 maximum shared variance (MSV) and average shared variance (ASV), and their values should  
17 be less than the AVE values for each construct (see Table 3). These results support our previous  
18 conclusions regarding discriminant validity. Finally, the GoF index for the CFA model was  
19 assessed. We obtained the following values: Normed Fit Index (NFI) = 0.943 > 0.90, Relative  
20 Fit Index (RFI) = 0.930 > 0.90, Incremental Fit Index (IFI) = 0.985 > 0.90, Tucker-Lewis Index  
21 (TLI) = 0.980 > 0.90, Comparative Fit Index (CFI) = 0.984 > 0.90, Goodness of Fit Index (GFI)  
22 = 0.949 > 0.90, Adjusted Goodness of Fit Index (AGFI) = 0.928 > 0.90, Root Mean Square  
23 Error of Approximation (RMSEA) = 0.038 < 0.08. From these results, we conclude that our  
24 CFA model is fit (Byrne, 2016; Kline, 2016; Nye, 2022; Whittaker & Schumacker, 2022).

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53 \*\*\*\*\* please insert Table 3 about here\*\*\*\*\*

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55 \*\*\*\*\* please insert Table 4 about here\*\*\*\*\*

#### 4.2. Structural model evaluation

We evaluate the structural model by looking at several core metrics associated with the model. First, we looked at  $R^2$  values to show the variance explained by the predictors to the outcome. In our model, we obtained  $R^2$  values ranging from 0.129 – 0.566 for SCA and GKA, respectively. According to Cohen et al. (2003), the  $R^2$  generated by our model belongs to the medium to large category (where small =  $< 0.10$ ; medium =  $< 0.30$  but  $\geq 0.10$ ; and large = between 0.30 – 0.50 or more). We argue that the  $R^2$  generated by this model is reasonable, given that our proposed model is quite simple and consisting of one independent variable, one mediator and one dependent variable. Our  $R^2$  values indicate that 12.9% of the variance from SCA can be explained by GPMP and GKA. While the remaining 87.1% is explained by other factors not included in this model. We further argue that the value of  $R^2$  will be highly dependent on the number of predictors in the model and this value will continue to increase when an independent variable is added to the model (Cohen et al., 2003; Cohen, 1988). However, when an  $R^2$  value that is too high and close to 1 is generated (e.g., 0.75 or 0.90), it indicates a multicollinearity. Based on this rule of thumb, our  $R^2$  values can acceptable for social science research.

Hereafter, we assessed the values of  $f^2$  to indicate the strength of the relationship between the two variables. Basically, the values of  $f^2$  inform that two relationships between variables eligible to be tested (Kline, 2019). The values of  $f^2$  were checked to support the use of the null hypothesis significance testing (NHST). The values of  $f^2$  are required to be more than 0.15 to indicate the strength of the relationship between the two variables. On the other hand, the  $f^2$  values are close to zero, indicating that the two relationships are not worthy to be tested. We found  $f^2$  values ranging from 0.201-0.506 which met the threshold for true effects.

Finally, we assess GoF indices to show the fit between the structural model and the observational data. We selected several fit indices that were not distorted by the number of

sample sizes (Kline, 2016). In this case, we obtained the following values as depicted in Figure 2 and Table 5: comparative fit index (CFI) = 0.984 > 0.90, Tucker-Lewis index (TLI) = 0.980 > 0.90, incremental index of fit (IFI) = 0.984 > 0.90, goodness-of-fit index (GFI) = 0.949 > 0.90, parsimony CFI (PCFI) = 0.800 > 0.60, parsimony GFI (PGFI) = 0.669 > 0.60, Steiger-Lind root mean square error of approximation (RMSEA) = 0.038 < 0.08 and root mean square residual (RMR) = 0.042 < 0.08. From these results, we conclude that our structural model is fit (Byrne, 2016; Kline, 2016; Whittaker & Schumacker, 2022).

\*\*\*\*\* please insert Figure 2 about here\*\*\*\*\*

\*\*\*\*\* please insert Table 5 about here\*\*\*\*\*

#### 4.3. Hypothesis testing

We use the ML estimator to test the hypotheses for both direct and indirect effects based on standardized coefficients. We look at the values of beta coefficient ( $\beta$ ), standard error (SE) and critical ratio (CR) generated by AMOS 28.0 program to confirm acceptance or rejection of the tested hypotheses. Based on Figure 2 and Table 6, we supported all of our proposed hypotheses. In this regard, we examined the direct effect (without mediation), and found the relationship between GPM practices  $\rightarrow$  SCA (c) significant at CR 4.863 > 3.09, with beta coefficient = 0.348 and SE = 0.080 at  $p$ -value = 0.000 < 0.001. Based on these preliminary results, we have support for hypothesis 1 (H1).

Furthermore, we estimated the full model (both direct and indirect effects), and obtained the following results. We obtained empirical support for the path relationship GPM practices  $\rightarrow$  SCA (c') with beta coefficient = 0.243, SE = 0.136 and significant at CR = 2.007 > 1.65 ( $p = 0.045 < 0.05$ ). Based on these results, we support our previous conclusion—H1 was supported. Finally, we found the indirect path relationship GPM practices  $\rightarrow$  GKA  $\rightarrow$



SCA with beta coefficient = 0.105, SE = 0.047 and significant at CR = 2.236 > 1.65 ( $p = 0.013 < 0.05$ ). From these results we conclude that hypothesis 2 (H2) was supported.

\*\*\*\*\* please insert Table 6 about here\*\*\*\*\*

#### 4.4. Robustness checks

Robustness checks are necessary to ensure that our main results were free from estimation bias. First, we assessed endogeneity bias associated with inverse causality, sample-selection bias, and omitted variables (Ullah et al., 2021). Using the Durbin and Wu-Hausman tests, we found a  $p$ -value > 0.05 for each regression equation. Therefore, we can assert that the endogeneity bias is not a threat to our main results. Second, we examined the potential for quadratic effects in our model. This test aims to support the assumption of a linear relationship between latent variables in our analysis and to support the correct specification of the model (Whittaker & Schumacker, 2022). We used Ramsey's regression specification error (RESET) and found that all relationships yielded  $p$ -values > 0.05. From these results, we conclude that there is no misspecification of the model (Whittaker & Schumacker, 2022).

## 5. Discussion and conclusion

### 5.1. Discussion of the results

The study examined the impact of GPM practices on SCA along with the mediating effect of GKA. To begin with, the findings of the H1 confirmed that GPM practices are positively related to SCA. The results are consistent with the previous study (Severo et al., 2020) and argues that GPM practices are primarily related to methodology and systems (as highlighted in this study) significantly influence firms' success and need to adopt GPM practices to gain SCA. Because the formation of GPM practices constructs highlight five crucial elements: 1) use the idea of project's various stages and duration; 2) to enhance and

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3 preserve the quality of projects using support tool; 3) best practices to reduce scope deviations  
4 and achieving project milestones; 4) framework for controlling operation timeline and budget;  
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6 5) framework for tracking project's documentation; 6) storing the documented knowledge to  
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8 create environmental awareness and learning for people. The above points show that the  
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10 relevance of direction to create GPM is undoubted because it adds value to the organization  
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12 when it is well implemented. Sáenz et al. (2009) added that, in addition to the production of  
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14 ideas, budget and project timeline are improved if there is any successful PM. Additionally,  
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16 GPM is precise and helps to expand entrepreneurial growth. However, the market and  
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18 stakeholders must note the various procedures, as the practices and policies should fulfil the  
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20 external environment's challenges. Besides, the findings assist in the management decision-  
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22 making process by demonstrating that enterprises using GPM increase the probability of  
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24 success by utilizing the resources for SCA. However, to achieve SCA, enterprises using such  
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26 information will need gain expertise to obtain resources (knowledge) and then engage in  
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28 acquisition of that knowledge.  
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35 The findings of H2 confirm a significant indirect effect of GKA between GPM and  
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37 SCA. Consistent with previous studies (Wang et al., 2020), green knowledge is further  
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39 developed into new product patents and the use of new knowledge, such as the predecessor of  
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41 SCA. The prime reason for this is that project-based enterprises' innovation uses PM  
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43 methodology which is significant for building techniques that facilitate and strengthen  
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45 enterprises' competitive edge (Špundak, 2014). This further fulfils the statement suggested by  
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47 Kanuri and Mcleod (2016) about the rivalry between companies as they require to build a  
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49 blockade to avoid and reduce the rivalry. With competitive differentials during knowledge  
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51 acquisition, these barriers can be applied. Particularly, acquisition of green knowledge is more  
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53 successful when particular GPM frameworks are used as GPM practices have not only direct  
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55 influence on SCA but also have an indirect impact on SCA via GKA. Medina & Medina (2015)  
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3 note that usually knowledge-intensive companies are project-oriented and intensification of the  
4 acquisition of green knowledge will encourage the quest for factors that affect a project's  
5 progress. In this way, companies' innovative advancements occur via changes to facilitate  
6 performance outcomes of the projects (Severo et al., 2020). This follows technical and  
7 operational management, including the execution of the scope of the organizational goals.  
8 Consequently, the alignment of processes aimed at producing outcomes by continuous  
9 operations of companies is configured by GKA, which can boost work quality and  
10 performance.

## 11 12 13 14 15 16 17 18 19 20 21 22 *5.2. Theoretical implications*

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24 The study makes several theoretical contributions. First, this research's main academic  
25 contribution is to statistically validate the PM practices scale and then extend its scope in the  
26 context of greening. The study is first of its kind to highlight and empirically differentiate the  
27 concept of GPM practices although few conventional case studies tried to stress on this less  
28 researched topic (Al-Qassab et al., 2019). Since there is a little or no research on this area,  
29 therefore, the study broadens our understanding on GPM practices from the perspective of KM.  
30 Moreover, this study provides the empirical evidence on the missing linkage and neglected role  
31 of GKA between GPM and SCA.

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Second, study develops and validate a framework to analyze the constructs of this study  
to test the measurement and hypothesized model. We expand the findings grounded in RBV.  
According to Malik and Ali (2022), prior relevant knowledge can help a firm apply and acquire  
knowledge to increase its competitive position because it significantly impacts how well firm  
resources are assimilated and utilized (Song et al., 2020). We advance the RBV theory by  
conceptualizing the role of GPM practices and extracting the viewpoint with GKA. Our study  
illustrates the essential role of knowledge acquisition in achieving SCA. It shows that GKA  
provides a facilitating mechanism between GPM practices and SCA. **Based on RBV, the study**

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3 conceptualized GPM practices as an important intangible resource from the organizational  
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5 perspective. Organizational resources such as organizational processes and procedures are the  
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7 key for achieving competitive advantage (Barney et al., 2021a; Freeman et al., 2021). We  
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9 extend the scope of RBV and posit that GPM practices provide an essential overview for  
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11 resource allocation and moving towards more sustainable value creation under SDGs. The  
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13 allocation of resources (tangible and non-tangible) can be realized in more efficient way with  
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15 GPM practices for achieving environmental SDGs by reducing carbon emission, material waste  
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17 and land protection and energy losses. Consistently, green knowledge is the individual  
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19 dispositional factor that is a human capital resource which further activates SCA. Therefore,  
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21 the study extends the assumptions of RBV (Barney, 1991) by conceptualizing and extending  
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23 two useful organizational and human capital resources for achieving and sustaining competitive  
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25 advantage.  
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31 Third, the results of the study significantly contribute to KM literature by bringing the  
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33 fore of understanding the GPM practices and knowledge acquisition as an important ingredient  
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35 for environmental sustainability by leading to SCA. Since, few research efforts have analyzed  
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37 the role of GKA on environmental performance outcomes (Sahoo et al., 2020). Our research  
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39 findings advance the extant research by revealing how GKA facilitates the role of GPM  
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41 practices and SCA. Finally, the study uses the unique sample from the Pakistani firms which  
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43 adds to the scant literature in the non-western context.  
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### 48 *5.3. Managerial implications*

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50 This study provides important implications for the managers and decision-makers  
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52 within the project-based enterprises. First, the study shows the importance of GPM practices  
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54 in enterprises. Due to immerse pressure on firms to main sustainability through following ESG  
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56 criteria, Carbon peak, Carbon Neutrality, or SDGs, enterprises need systematic and sustainable  
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58 methodological practices (such as GPM practices), resulting in dampened market permanence  
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3 and competitiveness. Using GPM practices, enterprises or manufacturing specialists can build  
4  
5 more responsible operations while conducting green projects, providing a substantial boost to  
6  
7 the fulfilment of the SDGs. Robichaud and Anantatmula (2011) asserts that including  
8  
9 sustainability into PM allows managers to understand organizational value, opens up new  
10  
11 options, lowers risks, boosts profits, and lowers expenses. GPM practices will also assist the  
12  
13 enterprises bottom line and brand reputation grow by demonstrating to potential customers that  
14  
15 the enterprise is socially and environmentally responsible (Khalifeh et al., 2020). Going green  
16  
17 can therefore give enterprises a competitive advantage.  
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22 Second, enterprises can enhance their green knowledge capabilities at the organization  
23  
24 level and increase their workers' capacity to gain green knowledge on an interpersonal basis  
25  
26 through on-job training and coordination. Manufacturers should start with a focus on  
27  
28 assimilation and acquisition of knowledge resources, as beneficial forces behind environmental  
29  
30 sustainability. The findings further encourage businesses to be creative by encouraging  
31  
32 corporate environmental sustainability by developing sustainable procedures committed to the  
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34 methodology of GPM, aiming synergy between fulfilling the required managerial changes for  
35  
36 customer satisfaction. Likewise, manufacturers who invest and involve more in GPM practices  
37  
38 are in better position in keeping an enterprise competitive and optimizing organizational  
39  
40 resources. GPM practices used in managing the acquisition of green knowledge will deliver  
41  
42 SCA, further increasing the organization's effectiveness. Thus, managers should invest more  
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44 in sustainable practices (e.g., GPM) and made aware of the importance of environmental SDGs  
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46 for sustainable development.  
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51 Third, our findings demonstrate that knowledge acquisition is necessary for  
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53 manufacturers to meet the goals of reducing manufacturing emissions and enhancing firms'  
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55 capacity to minimize their environmental effect. It is noteworthy that the environmental  
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57 outcomes such as environmental sustainability are the criterion for decision-making for  
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3 potential GPM techniques as a practical application of the research results. The results show  
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5 that enterprises with GPM practices often prosper by gaining green knowledge. Due to the fact  
6  
7 that firms engaged in such processes are better at encouraging investment when actively  
8  
9 seeking resources and implementing change initiatives to direct more pathways (Hoppmann et  
10  
11 al., 2018). Finally, the study helped to define the factors that most affect competitive position  
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13 of firms with GMP practices: using the program to track plans, budgets, the life cycle of the  
14  
15 project and encourage quality advancement; preserving the proposed requirements and  
16  
17 objective of the project; participation in people's learning focused on projects which were  
18  
19 introduced and documented. Consistently, acquired green knowledge in the production  
20  
21 process, social initiatives to develop new products, cleaner production processes, and shared  
22  
23 ownership vision, could assist to act on SDGs such as reducing toxic materials and decrease  
24  
25 material consumptions and retrieval components from the end-of-life products. Hence,  
26  
27 managers should concentrate on knowledge resources and better leveraging knowledge  
28  
29 acquisition activities that are crucial to the development of their competences in the pursuit of  
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31 environmental SDGs for SCA. Such activities ensure several core aspects of efficient GPM,  
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33 the acquisition of green knowledge, by incorporating PM processes to produce SCA.  
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#### 41 *5.4. Limitations and future research directions*

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43 The study has some limitations. First, this study's design is cross-sectional, limiting our  
44  
45 ability to make causal inferences regarding the relationships tested in the study. Although we  
46  
47 attempted to address method bias issues, future research may use a time-lagged or a  
48  
49 longitudinal design to examine whether GPM practices influence GKA and SCA over time. In  
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51 addition, this research design is also useful in testing the mediating effect to better support  
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53 claims of cause-effect relationships and increase the internal validity of the findings (Kline,  
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55 2015). Second, our study focused on project-based organizations involve in green projects in a  
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57 developing economy (i.e., Pakistan). Future research may replicate the study in other developed  
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3 and underdeveloped countries to see if GPM practices have different outcomes across cultures.  
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5 Finally, although our study focused on the RBV framework encompasses a wide array of  
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7 resources (e.g., valuable, rare, inimitable and organized) that may help workers gain and sustain  
8  
9 competitive advantage through GPM practices. Future research may further explore an NRBV  
10  
11 (Hart, 1995) to explore these domains using various mechanisms. For example, strategic  
12  
13 capabilities (including pollution prevention and sustainable development) may induce  
14  
15 environmental forces (i.e., minimizations of emissions, production cost and environmental  
16  
17 burden of firm growth and development) that help to identify the relevant resource capacities  
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19 (e.g., continuous improvement, stakeholder integration and shared vision) that lead towards  
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21 SCA. Future research may examine the buffering role of more domain-specific moderators  
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23 (e.g., project interdependency and project culture) for the effects of GKA.  
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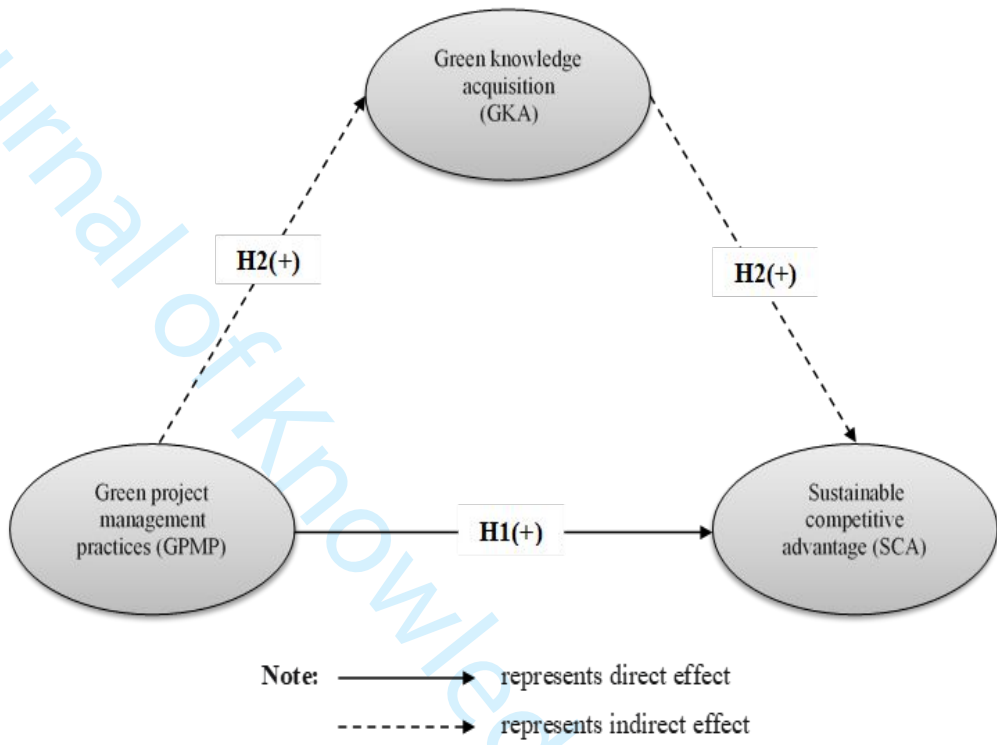


Fig 1. Theoretical framework and the relationship among variables.

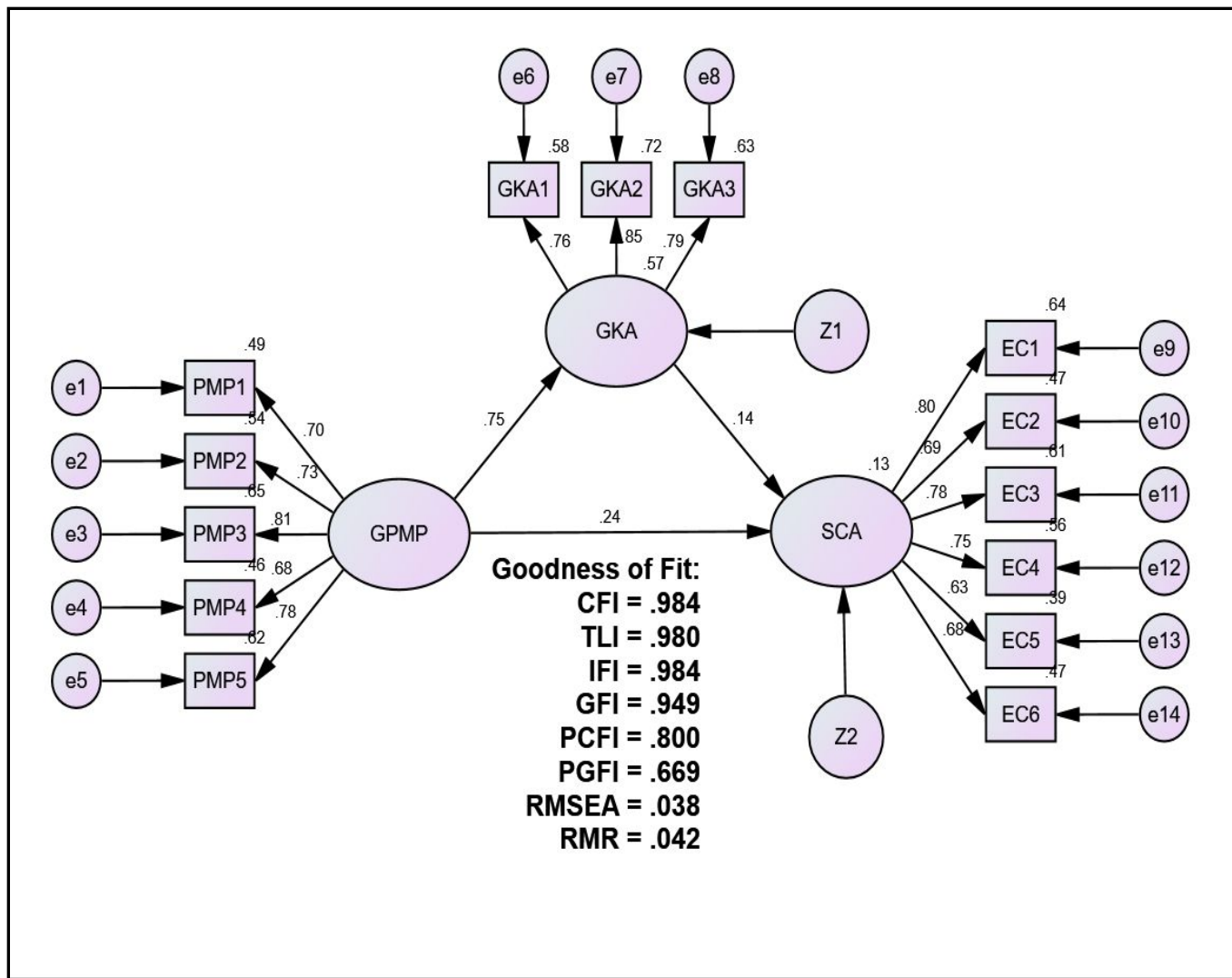


Fig 2. Measurement and structural model results.

**Table 1** Assessment of non-response bias and common method variance.

Latent Factor	Sig. Levene's Test	Sig. <i>t</i> -test for Equality of Means	CFA Marker
Green project management practices (GPMP)	0.988	0.862	
Green knowledge acquisition (GKA)	0.582	0.954	
Sustainable competitive advantage (SCA)	0.878	0.540	$r = 0.093$

Note(s): CFA = confirmatory factor analysis

**Table 2** Sample characteristics ( $n = 265$ ).

Characteristics	Classifications	Freq ( <i>f</i> )	Perc (%)
Gender	Male	194	73.2
	Female	71	26.8
Experience	Less than 1 year	12	4.5
	1 to 5 years	78	29.4
	More than 5 years	175	66.0
Project duration	Less than 1 year	74	27.9
	1 to 2 years	76	28.7
	More than 2 years	115	43.4
Educational background	Bachelor's degree	86	32.5
	Master's degree	135	50.9
	Technical degree	44	16.6
Age	20 to 29 years	62	23.4
	30 to 39 years	133	50.2
	40 to 49 years	51	19.2
	More than 50 years	19	7.2

Note(s): Freq = frequency; Perc = percent.

**Table 3** Summary of measurement constructs.

Item Description	Code	Mean	SD	SFL	AVE	MSV	ASV	$\alpha$	$\rho_c$
<b>A) Green project management practices (GPMP)</b>					0.55	0.12	0.12	0.85	0.86
In my enterprise, the managers admit the green project management needs due to the implementation advantages of such methodology.	PMP1	3.317	1.128	0.698					
Our managers have good knowledge of the green project management principles and they support the lectures, courses and articles by attending meetings and through the projects' team reports.	PMP2	3.460	1.042	0.732					
Our managers were trained and instructed in green project management. They are committed to this management and to the deadline observance established for the reaching of objectives. They also dismiss their employees to attend training sessions on green project management.	PMP3	3.396	0.954	0.805					
My enterprise has a methodology of green project management and uses the concept of environmental sustainability and life circle of a project. We use support software and keep committed to early planning aiming at quality, and we do whatever possible to minimize environmental hazards and scope deviation in the projects.	PMP4	3.430	1.051	0.681					
My enterprise has a system to manage cost and project chronogram with variation control in relation to the objectives planned and follow-up reports. We keep a green project management file to improve our employees' qualifications, which is considered a professional role.	PMP5	3.442	1.038	0.785					
<b>B) Green knowledge acquisition (GKA)</b>					0.64	0.10	0.10	0.84	0.84
Our enterprise obtains a lot of technical knowledge related to environmental protection.	GKA1	3.257	1.130	0.763					



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Our enterprise obtains a lot of market knowledge related to environmental protection.	GKA2	3.317	1.200	0.846					
Our enterprise obtains a lot of product and service knowledge related to environmental protection	GKA3	3.309	1.176	0.793					
<b>C) Sustainable competitive advantage (SCA)</b>					0.52	0.30	0.30	0.86	0.87
Our success rate for new products/services is much better compared to competitors.	EC1	2.913	1.144	0.798					
Our revenue from new products/services is much better compared to competitors.	EC2	3.026	1.124	0.687					
Profitability with new products/services is much better compared to competitors.	EC3	3.004	1.104	0.778					
The overall performance of our company in the previous year was superior to the main competitors.	EC4	2.943	1.113	0.749					
Our total operating costs are lower than our competitors' total costs.	EC5	2.932	1.117	0.626					
Our company's corporate image is better than that of the competitors.	EC6	3.026	1.134	0.683					

Note(s): SD = Standard deviation; SFL = Standardized factor loading; AVE = Average variance extracted; MSV = Maximum shared variance; ASV = Average shared variance;  $\alpha$  = Cronbach's Alpha;  $\rho_c$  = Composite reliability.

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**Table 4** Assessment of discriminant validity using the HTMT and HTMT2 indices.

Latent Factor	1	2	3
Green knowledge acquisition (GKA)	<b>(0.85)</b>	0.635**	0.271**
Green project management practices (GPMP)	0.751 [0.753]	<b>(0.85)</b>	0.307**
Sustainable competitive advantage (SCA)	0.316 [0.316]	0.357 [0.359]	<b>(0.85)</b>

Note(s): Brackets show the HTMT2 index; the values above the diagonal show the correlation between variables; the values below the diagonal show the HTMT index; \*\* statistically significant at the  $p < 0.01$  (two-tailed test).

**Table 5** Structural model assessment.

Latent Factor	$R^2$	$f^2$	VIF	GoF	Cut-off	Decision
Green project management practices (GPMP)	–	0.506	1.706	CFI = 0.984 TLI = 0.980 IFI = 0.984	> 0.90 > 0.90 > 0.90	Fit Fit Fit
Green knowledge acquisition (GKA)	0.566	0.201	1.706	GFI = 0.949 PCFI = 0.800	> 0.90 > 0.60	Fit Fit
Sustainable competitive advantage (SCA)	0.129	–	–	PGFI = 0.669 RMSEA = 0.038 RMR = 0.042	> 0.60 < 0.08 < 0.08	Fit Fit Fit

Note(s):  $R^2$  = the coefficient of determination;  $f^2$  = effect size; VIF = variance inflation factor; GoF = goodness of fit indices.

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**Table 6** Summary of hypotheses testing.

Structural path relationships	Coef( $\beta$ )	SE	CR	p-value	Conclusion
<i>(A) Total effect model</i>					
GPM practices $\rightarrow$ Sustainable competitive advantage (c)	0.348***	0.080	4.863	0.000	H1 supported
<i>(B) Direct effect model (H1)</i>					
<b>H1</b> = GPM practices $\rightarrow$ Sustainable competitive advantage (c')	0.243*	0.136	2.007	0.045	H1 supported
<i>(C) Indirect effect model (H2)</i>					
<b>H2</b> = $a_1b_1$ (via Green knowledge acquisition)	0.318***	0.081	3.920	0.000	H2 supported

**H2:** GPM practices  $\rightarrow$  Green knowledge acquisition  $\rightarrow$  Sustainable competitive advantage ( $a_1b_1$ )

Note(s): Coef( $\beta$ ) = Beta coefficient; SE = Standard error; CR= Critical ratio; \*  $|CR| \geq 1.65$  at  $p < 0.05$  level; \*\*  $|CR| \geq 2.33$  at  $p < 0.01$  level; \*\*\*  $|CR| \geq 3.09$  at  $p < 0.001$  level.

