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Analysing Skills Needed For Doctoral Researchers: A Systematic Literature Review

Parul Pandey[1*], Urvashi Kaushal[2]

[1,2]Sardar Vallabhbhai National Institute of Technology, Gujarat, India
[1*] parulp42@gmail.com,
[2] k.urvashi@amhd.svnit.ac.in

Abstract : The skill development of doctoral researchers has been the subject of several research studies conducted in the last few decades. However, there's been a dearth of a systematic literature review in the literature pertaining to doctoral researchers. Hence, the aim of this first-of-its-kind SLR on doctoral researchers belonging to STEM, Management, and Humanities is to analyse skills needed for doctoral researchers by preparing a consolidated list of skills along with their rankings. This SLR has also highlighted the limitations of the research methodology used in the studies and the implications for the stakeholders involved in the process of researcher development. This systematic literature review (SLR) included 48 empirical and theoretical research studies synthesized in a comprehensive manner, and the findings revealed: a) a consolidated list of 35 skills along with their rankings for doctoral researchers; b) 40% studies had a sample size below 50, and there's a dearth of studies having a mixed method approach; c) the formulation of a list of skills can help the stakeholders design and incorporate programs to inculcate these skills in doctoral researchers and ensure successful completion of PhD, reduce attrition rates, and increase researchers' employment in academia and industry. It is recommended that future studies have a standalone SLR with empirical studies for doctoral researchers to lend credibility, validity, and generalizability to the study and produce standard results. Additionally, preparing a similar standalone study for researchers belonging to STEM, Management, and Humanities is recommended.

Keywords: Doctoral researchers; Employability; Researcher development; skills; STEM; Systematic literature review.

Parul Pandey
Sardar Vallabhbhai National Institute of Technology, Gujarat, India
parulp42@gmail.com,

1. Introduction

The innovation and economy of a nation are developed by research education. Hence, it's important for the literature on doctoral researchers, who occupy a huge section of the research community of any nation, to be focused on, but they are often ignored (Mitic & Okahana, 2021;Smith et al., 2014).

Indeed, the embedding of skills and the encouragement of skill development directly impacts the efficiency and employability of the doctoral researchers. (Moore & Morton, 2017). In fact, the promotion of employability through enterprise

education can help students develop the life skills that are at the core of the learners (Lean, 2012). Industry internships are becoming a growing trend in academic programs, driven by the need to enhance students' skills, making them more prepared for the workforce and improving their chances of securing placements (Bagewadi et al., 2020; Bansal et al., 2022; Izam & Hasan, 2022). Engineering institutes are expected to address current global issues and actively involve students in them. Industries, on the other hand, emphasize the importance of investing in personal skills for both the overall growth of the industry and individual development (Gandhi et al., 2021;Haldar et al., 2021;Joshi et al., 2022). A strong collaboration between academia and industry is essential to meet both business and environmental needs. Therefore, it is important for the industry to actively engage and contribute to academic institutions (Mamatha et al., 2020; Kaushal & Vaghela, 2023;Navalgund et al., 2021).

Similarly, it has been stated by Bromley and Warnock (2021) that researcher development is characterized by "behavioral, attitudinal, and intellectual development" (p.285). Though the term has rarely been defined, it cannot be denied that there are "common threads in the research surrounding the development of the skill set of researchers which include knowledge, attributes, competence, confidence, intellectual development, and learning". These skills not only ensure positive changes in a researcher and "benefit their research activity and output but also influence their personal and career development". (Bromley & Warnock, 2021,p. 285). In fact, it was also stated that a sound definition of researcher development should include “behavioural change towards achieving competence in attributes considered to be those of researchers” (Bromley & Warnock, 2021, p.285).

The role of a PhD degree in making research scholars skilled has been debated by several researchers, as it is argued that having a PhD degree alone does not necessarily enable doctoral researchers to establish a niche in the competitive academic and professional world (Boddy, 2007; Moore & Morton, 2017; Platow, 2012). The inclusion of skills programs and students' feedback towards these programs has been recorded in several studies, as critiquing the skills programs at the research level can help in determining several issues. (Mowbray & Halse, 2010). A few skills that are expected to be acquired by a doctoral researcher funded by the UK research council and AHRC were listed out. Such programs included the GRAD program in the UK, University of Washington's Re-Envisioning the PhD in the USA, etc. (Gilbert et al., 2004; Manathunga et al., 2009). Important skills such as "identifying project-specific skills, cognitive skills, discipline-specific skills, and career and professional practice skills" to attain success in research and employment have been listed out by the Directors of Graduate Studies and Council of Australian Deans in Australia. Out of 19 generic skills, 10 have been deemed crucial by 80% of research students, which include leadership, communication, etc. In fact, it has been established by UK researchers that important professional, transferable, and practical skills need to be developed in the PhD scholars to groom them for a career in both industry and academia (Gilbert et al., 2004; Lean, 2012; Park, 2005). Development and acquisition of different skills are ensured by different activities, such as the organization of conferences by doctoral researchers, which could instill skills of collaboration, negotiation, and ability to manage funds during PhD etc. (Disney et al., 2013).

Additionally, it was also found that perceptions of the major stakeholders involved are required for decoding the skills for PhD (Barnard et al., 2019; Ulrich & Dash, 2013; Wiles et al., 2009).The skills and behavior expected of a research scholar from either their industry counterparts or the supervisors have also been attempted to be incorporated by studies, but other stakeholders such as the role of administration or the policymakers have not been taken into account (Germain-Alamartine Moghadam-Saman, 2019). Despite having been highlighted by several past studies, it is understood that the employability of a doctoral researcher can be directly impacted by awareness and acquisition of these skills (C. Jackson et al., 2019). The factors, skills, and motives that drive a PhD scholar to pursue and navigate through the journey of a PhD and finish the research successfully were previously explored (Burt et al., 2017; Park, 2005). Teamwork, creativity, and basic theoretical knowledge were found to be important by Shmatko (2016) and will remain relevant even after 15 years, while several other skills are needed to be inculcated by the employers during the job (Shmatko 2016).

Additionally, the role of learning several interpersonal and intrapersonal skills during the journey of the PhD by the doctoral researchers themselves has been explored by many past studies, as

there is a difference in the skills acquired by researchers during their doctoral education and the skills, knowledge, and ability hoped to be gained out of a PhD by students (McAlpine & Asgharb, 2010). It has also been highlighted by past studies that due to the lack of awareness of these skills, many scholars were not ready for such skill-inducing initiatives, and there has been difficulty in including international students in such initiatives and also in coordinating between faculty and scholars (McAlpine and Asgharb, 2010).

Examination of abilities and a lack of knowledge about what is required of PhD scholars at various stages such as when they enroll in the program, while writing their thesis, when getting ready for the viva, etc., has been documented by past studies (Ciampa & Wolfe, 2019). During Viva, different skills such as the ability to think creatively without any assistance from the supervisors, effective research presentation skills backed with good knowledge of the research discipline, along with the ability to handle pressure and lead different projects, are required (Tinkler & Jackson, 2002). It is necessary to deconstruct each step of research into its fundamental needs for attributing skills.

In fact, a study has been conducted to identify research skills expected of doctoral researchers in the future (Lean, 2012). Several skills that would be expected of a researcher in the future, such as digital skills, having an interdisciplinary or multidisciplinary approach, teamwork, networking abilities, and communication skills, etc., have been identified by senior managers and researchers from 8 countries such as the USA, Germany, Japan, Finland, France, New Zealand, UK, and Switzerland (Ulrich & Dash, 2013). In fact, several researcher development frameworks, such as the Vitae Development framework, TDEM, UK Research Council, and AHRB listing the skills expected of doctoral researchers, have been proposed by different institutes and government bodies (Gilbert et al., 2004). Skills were divided into four categories - knowledge and intellectual abilities; personal effectiveness, research governance, and organization; and engagement, influence, and impact by Vitae's Development Framework (C. Jackson et al., 2019). After a rigorous scanning of studies, the best way to probe the recent trend of knowledge in this field was found to be a systematic literature review. New trends and the status quo of the knowledge in an area can be identified by a systematic literature review. Handling wide range of information that results from an academic investigation is accomplished by a crucial research tool called the literature review. A method to minimize bias and provide an audit trail for the study's findings that is scientific, transparent, and replicable is employed by a systematic literature review (SLR), which differs from regular literature reviews (Ahmed et al., 2021). In a systematic literature review, related articles on a given topic are comprehensively searched for, and those identified are then appraised and synthesized according to a predetermined method stated by the researcher (Ahmed et al., 2021). As a result, thorough coverage in a specific area, together with accuracy, transparency, and objectivity, is provided by the SLR approach. In the field of skills for doctoral researchers, a clear dearth of Systematic Literature Reviews is observed. Hence, in this paper, different keywords have been located from the papers that were found through choosing relevant databases on skills for doctoral researchers by us. It is revealed by the systematic literature review that only one important review study has been conducted in the past ten years by Bromley & Warnock (2021). The concept of researcher development has been discussed in detail in this study. Apart from this study, a lack of literature review on skills for doctoral researchers has been found in the existing literature. Therefore, this study has been conducted by us, as the current trends of knowledge in any field are popularly surveyed by systematic literature reviews (Ahmed et al., 2021).

The expansion of academic study into the effectiveness of developmental strategies for PhD and early career researchers was documented in a review paper by Bromley and Warnock (2021). The objective of their study was to present a "State of the Art" review of the growing research domains as well as to identify fields that require further investigation. A fundamental gap exists in the literature on producing researchers in all fields of literature pertaining to the study of this practice. In the context of "research governance, work-life balance, and engagement influence," it was determined by them which domains have the least published research (Bromley & Warnock, 2021, p.288). In this study, it was noted that this discipline, with limited or no review papers backing it, was emerging. Thus, the narrowed concept of researcher development was dealt with in this study. The review paper was limited to examining the concept of researcher development and understanding various aspects of the concept by presenting the status quo through citation of previous studies. The aim was to address questions regarding how doctoral

researchers develop both personally and professionally in terms of their publications and presentations during their research journey, and then to identify important gaps in the existing literature. Even though a comprehensive study was conducted, the SLR method has not yet been used to conduct research on skills for doctoral researchers, and systematic literature review methodology was not used.

Therefore, this gap is addressed by this SLR which has synthesised the existing peer reviewed papers on skills required in doctoral researcher. It focused on including studies by using SLR methodology to answer the below -mentioned questions:

- Which skills for doctoral researchers have been examined, and how frequently are they mentioned in the existing literature?
- What are the limitations of the research methodology of this study?
- What are the key implications for doctoral researchers and academicians based on existing research studies? (Ahmed et al., 2021)

The goal of this study is to construct a comprehensive account of skills for doctoral researchers by considering the studies representing the latest trends, as there is a dearth of systematic literature reviews on this topic.

The following structure is followed by the paper. Firstly, a synopsis of the studies tracing the origins of the doctoral researcher's skill development to produce the abovementioned research questions based on the relevant existing research studies. This is followed by further incorporating studies on doctoral researcher's skill development. The systematic literature review method is then briefly explained, along with details on the inclusion and exclusion criteria, databases and items searched, research methodology, sample, and matrix method. A summary of the systematic literature review has been presented. The results of a thorough literature review on the important skills for PhD researchers, which was based on 48 research studies, have been discussed after the analysis of research articles. The methodological contribution of the systematic literature review approach for this topic has been extensively discussed in the paper. In the discussion, the results have been described along with any implications and limitations and suggestions for future research followed by a conclusion.

2. Methods

A. Keywords Searched

The existing research papers examining doctoral researcher's skills, skill development, researcher development, or similar areas were identified in different databases. In 2016, a method was framed by Padalkar and Gopinath, which was followed in searching abstracts and titles of the published research papers in the doctoral researchers' literature, and it was followed to make sure that the articles included a sufficient amount of data on researcher development or the associated skills for doctoral researchers or skill development (Ahmed et al., 2021).

Next, an initial search as recommended by De Araujo et al. in 2017 was done through different databases using various keywords identified from existing literature such as: “researcher development”, “skills”, “skill development”, “doctoral researcher's skill”, “PhD skills”, “PhD skills development” and “doctoral researcher's skill development” etc. Limited results were yielded by database searches. Table I lists the number of published articles identified for each keyword in each bibliographic database by us.

Table 1 :
Number Of Publications Per Phrases Searched From Databases

Keyword /Databases	Researcher development	Skills / Competence	Skill development	Doctoral researchers skill	PhD/ PhD/ skills	PhD skills development	Doctoral researcher’s skill development	Doctoral/ Doctorate
Taylor and Francis	825	1,303	1,032	448	78	113	65	123
Web of Science	0	53	25	1	0	0	0	1
Emerald	735	1,438	1,474	297	86	55	58	137
Sage Journals	3	387	131	12	1	0	0	7
AU Press, Canada	11	37	4	0	7	4	5	02
Scopus	373	532	515	212	58	119	27	104

B. Databases Searched

In accordance with the methods of Busalim (2016) and de Araujo et al. (2017), the search for published

papers was systematically carried out using the abovementioned keywords and phrases following the sequence of the given databases. The following electronic databases were searched as part of the systematic literature review: Emerald, SAGE Journals, Scopus, Taylor & Francis, AU Press, and Web of Science. The published articles, titles, and abstracts were examined by researchers for consideration in this literature review. Additionally, only peer-reviewed journal papers published in English were included in all search results (Ahmed et al., 2021).

C. Research Design

For this research study, abstracts were retrieved if they contained the following terms: (1) researcher development; (2) skill development, or doctoral researcher's skills; (3) PhD skills or PhD skills development; (4) doctoral researcher in reference to competence, ability, skills, doctoral, doctorate etc. This technique ensured that the relevant coverage of skills for doctoral researchers was present in the published articles. Abstracts meeting these requirements were assigned a rank of one or two according to the significance of the content and the research findings. Figure 1 demonstrates the procedures that were followed and the suitable rating criteria that were applied during the selection of the abstracts and the articles, in accordance with the method proposed by Ali and Miller in 2017 and Igarashi et al. in 2013 (Ahmed et al., 2021). Articles with irrelevant results or those that only had the sought keywords in the background or discussion were allotted third position after this initial evaluation and were eventually excluded. The first position and the second position abstracts were carefully examined and selected for the review of the articles based on the inclusion of keywords such as doctoral researcher's skills, skill development, competence etc. in the important sections of the papers (Ahmed et al., 2021).

D. Inclusion and exclusion criteria

The methodology employed by Igarashi et al. in 2013 to determine the inclusion and exclusion criteria for article selection was used (Ahmed et al., 2021). The initial search stipulated to ensure that the articles included in this study had to satisfy four criteria in order to be eligible for inclusion: (1) they had to be in English language; (2) they had to be published in journals that were peer-reviewed; (3) they had to be connected to the researcher development area; and (4) they had to contain the specific keywords. A synopsis of the number of articles located using particular keywords in each database over a defined period of time is depicted in Table 1. The papers from the searched databases were then checked by the researcher to see whether there were any duplicates.

To maintain track of the overall number of new articles discovered, the duplicate journal articles were then counted and eliminated from the previous database search by the researcher. The eligibility was checked against the inclusion criteria in the second screening phase, after which full papers that met the inclusion criteria were selected from the relevant databases.

The following requirements had to be met by the published papers to be incorporated in the second screening: (1) research articles should be peer-reviewed; (2) terms pertaining to skills for doctoral researchers either in the title of the paper or the abstract had to be included; and (3) the skills for doctoral researchers had to be investigated either theoretically or empirically.

If any of these inclusion criteria were not met in any section of the research paper, the article would be excluded.

E. Sample Size

The technique described by Ali and Miller (2017) to

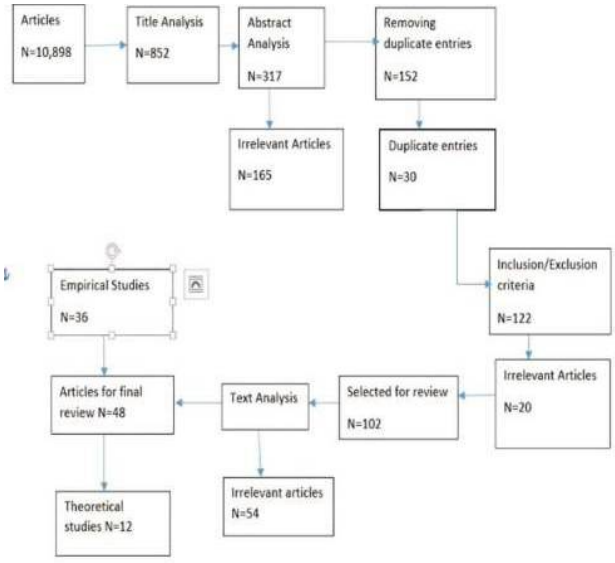

Fig 1 : Flowchart showing Systematic Literature Review Process

find peer-reviewed papers was followed by including the key phrases listed in the section detailing the inclusion and exclusion criteria. It was corroborated by the numerous publications found using search phrases from various databases that there has been an increase in interest in the literature pertaining to researcher development. As shown in Fig 1, a total of 852 papers were found after scanning the databases, and 317 of those were chosen after title analysis using the method proposed by Igarashi et al (2013) (Ahmed et a l. 2021). After that, an abstract analysis was performed and 165 irrelevant papers were eliminated. Additionally, 30 duplicates were excluded, leaving 122 articles that met the original inclusion criterion. Following that, 20 publications were disqualified on the basis of the exclusion and inclusion criteria because they didn't fit the study's objectives. A sample of 102 articles was selected after filtering the papers in compliance with the abovementioned criteria of inclusion and exclusion. Then, 54 articles were eliminated since their topics did not pertain to skills for PhD researchers, which was discovered during text analysis of the full articles. After synthesizing the research papers that matched the criteria of inclusion for SLR on skills for doctoral researchers, a sample of 48 research papers was selected for the SLR.

Of these 48 studies, 36 empirical and 12 theoretical studies were found from 27 different journals and three different publishers. This comprised 27 studies from Taylor and Francis, 20 studies from Emerald publishers, and 1 study from AU Press, Canada. The publications from the systematic literature review are summarized in Table II.

Table 2 :
Summary of Systematic Literature Review Publications

Database/ Publisher	Journal	No. of articles	Literature review
Taylor and Francis	Higher Education Research and Development	4	(Blaj-Ward, 2011; Craswell, 2007; Gilbert et al., 2004; Mowbray & Halse, 2010)
Emerald	Studies in Graduate and Postdoctoral Education (Formerly known as International Journal for Researcher Development)	10	(Bromley & Warnock, 2021; Burt et al., 2017; Ciampa & Wolfe, 2019; C. Jackson et al., 2019; Mitic & Okahana, 2021; Patterson et al., 2020; Sakurai & Pyhältö, 2021) (Dash, 2015; Saunders, 2009; Walsh et al., 2010)
Taylor and Francis	Studies in Higher Education	8	(Barnacle & Dall'Alba, 2013; Hancock & Walsh, 2014; D. Jackson & Michelson, 2014; Mantai & Marrone, 2022; Moore & Morton, 2015; Muñoz et al., 2019; Pilbeam et al., 2013; Platow, 2012)
Emerald	Foresight	1	(Shmatko, 2016)
Taylor and Francis	International Journal for Academic Development	1	(McAlpine & Asgharb, 2010)
Taylor and Francis	Planet	1	(Disney et al., 2013)
Emerald	Journal of Small Business and Enterprise Development	1	(Lean, 2012)
Taylor and Francis	Innovations in Education and Teaching International	1	(Barnard et al., 2018)
Emerald	Marketing Intelligence and Planning	1	(Boddy, 2007)
Emerald	Education and Training	1	(Smith et al., 2014)
Emerald	Higher Education, Skills and Work-based Learning	2	(Buss et al., 2014; Candy et al., 2019)
Emerald	International Journal of Contemporary Hospitality Management	1	(Aguinis et al., 2021)
Emerald	Global Knowledge, Memory and Communication	1	(Hussain et al., 2022)
Emerald	Quality Assurance in Education	1	(Tinkler & Jackson, 2002)
Taylor and Francis	Regional Studies, Regional Science	1	(Germain-Alamartine, 2019)
Taylor and Francis	Journal of Geography in Higher Education	1	(Ferguson, 2009)
Taylor and Francis	European Planning Studies	1	(Germain-Alamartine & Moghadam-Saman, 2019)
Taylor and Francis	Policy Reviews in Higher Education	1	(Molla & Cuthbert, 2019)
Taylor and Francis	European Journal of Engineering Education	1	(Garcia-Perez & Ayres, 2012)
Taylor and Francis	International Journal of Social Research Methodology	1	(Wiles et al., 2009)
Taylor and Francis	Journal of Higher Education Policy and Management	1	(Park, 2005)
Taylor and Francis	Assessment and Evaluation in Higher Education	1	(Manathunga et al., 2009)
Taylor and Francis	Journal of Continuing Higher Education	1	(Stewart-Wells & Keenan, 2020)
Taylor and Francis	International Journal of Phytoremediation	2	(Lindner et al., 2001; Winston & Fields, 2003)
Taylor and Francis	Journal of Further and Higher Education	1	(Mullen et al., 2010)
AU Press, Canada	Journal of Research Practice	1	(Ulrich & Dash, 2013)
Emerald	International Journal of Educational Management	1	(Acharya & Rajendran, 2023)
	Total	48	

3. Analysis

The matrix method, proposed by Garrard (2013), was employed as a strategy for compiling and categorizing the relevant data from the articles. As a result, the following details were extracted from each article: (1) The skills required for doctoral researchers mentioned in any section of the paper (2) sample size (3) the adopted methodology (4) the key respondents and (5) country of origin of the research studies were included. Finally, 48 research studies were found and synthesised using the Matrix method. This comprised 5 studies that were published from 2001 to 2005, 10 studies published from 2006 to 2010, 14 studies published from 2011 to 2015, 12 studies published from 2016 to 2020, and 7 studies published from 2020 to 2023. A summary of the year in which these papers were published is displayed in Figure 2.

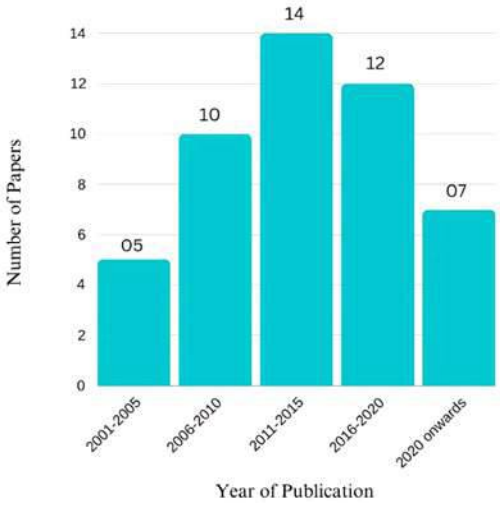

Fig 2 : Summary of the year of publication for the articles from the SLR

When the results of the literature review were analyzed in a broader context, it was realized that the competence of PhD researchers is a concern for many stakeholders in higher education. Additionally, a growing need is observed for the identification of the skills expected of doctoral researchers.

In fact, according to Bromley and Warnock (2021), it has been suggested that the current body of knowledge and theories may not be sufficiently comprehensive to enable the development of a robust model for inculcating skills in doctoral researchers. Additionally, a lack of interaction between different stakeholders such as researchers, faculty members, industry employers, etc., was also highlighted. The literature o n skills for PhD researchers has only been the subject of a limited number of studies. Only a limited number of studies focusing on skills for PhD researchers have been observed in the literature.

Both academia and industry are beginning to recognize the significance of skills that should be possessed by doctoral researchers. The differentiation of people's skill sets or combinations of skills from one another is influenced, in reality, by the field one is working in, the work environment, and the people involved.

A. Skills required for Doctoral researchers

The key skills displayed in Table 3, enlist skills that were mentioned in the introduction, literature review, results or discussion section of the 48 papers as an important skill for doctoral researchers. In each column, each skill is displayed, along with the frequency from the literature that corresponds to it as determined by the synthesis of the studies in this SLR.

A synthesis of the popularity of doctoral researcher's skills, the authors' names, and the year of publication is presented in Table III.

Table 3 :
Popularity of Doctoral Researcher's Skills Based on Slr

S.No.	Doctoral researcher's skills	Frequency	Literature references
1.	Knowledge	47	(Lindner, Dooley and Murphy, 2001; Tinkler and Jackson, 2002; Winston and Fields, 2003; Gilbert *et al.*, 2004; Park, 2005; Craswell, 2007; Boddy, 2007; Ferguson, 2009; Manathunga, Pitt and Critchley, 2009; Saunders, 2009; Wiles *et al.*, 2009; McAlpine and Asgharb, 2010; Mowbray and Halse, 2010; Mullen, Fish and Hutinger, 2010; Walsh *et al.*, 2010; Blaj-Ward, 2011; Garcia-Perez and Ayres, 2012; Lean, 2012; Platow, 2012; Barnacle and Dall'Alba, 2013; Disney *et al.*, 2013; Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Hancock and Walsh, 2014; Jackson and Michelson, 2014; Smith *et al.*, 2014; Buss *et al.*, 2014; Moore and Morton, 2015; Shmatko, 2016; Burt, Lundgren and Schroetter, 2017; Barnard, Mallaband and Leder Mackley, 2018; Germain-Alamartine, 2019; Germain-Alamartine and Moghadam-Saman, 2019; Jackson, Milos and Kerr, 2019; Molla and Cuthbert, 2019; Muñoz, Guerra and Mosey, 2019; Candy, Rodrigo and Turnbull, 2019; Ciampa and Wolfe, 2019; Patterson *et al.*, 2020; Stewart-Wells and Keenan, 2020; Aguinis, Yu and Tosun, 2021; Mitic and Okahana, 2021; Sakurai and Pyhältö, 2021; Bromley and Warnock, 2021; Hussain *et al.*, 2022) (Acharya & Rajendran, 2023; Mantai & Marrone, 2022)

2.	Identify/Create/Take/Seek opportunities	40	(Gilbert *et al.*, 2004; Park, 2005; Craswell, 2007; Boddy, 2007; Ferguson, 2009; Saunders, 2009; McAlpine and Asgharb, 2010; Mullen, Fish and Hutinger, 2010; Walsh *et al.*, 2010; Blaj-Ward, 2011; Garcia-Perez and Ayres, 2012; Lean, 2012; Barnacle and Dall'Alba, 2013; Disney *et al.*, 2013; Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Hancock and Walsh, 2014; Jackson and Michelson, 2014; Smith *et al.*, 2014; Buss *et al.*, 2014; Dash, 2015; Shmatko, 2016; Burt, Lundgren and Schroetter, 2017; Barnard, Mallaband and Leder Mackley, 2018; Germain-Alamartine, 2019; Germain-Alamartine and Moghadam-Saman, 2019; Jackson, Milos and Kerr, 2019; Molla and Cuthbert, 2019; Muñoz, Guerra and Mosey, 2019; Candy, Rodrigo and Turnbull, 2019; Ciampa and Wolfe, 2019; Patterson *et al.*, 2020; Stewart-Wells and Keenan, 2020; Aguinis, Yu and Tosun, 2021; Mitic and Okahana, 2021; Sakurai and Pyhältö, 2021; Bromley and Warnock, 2021; Hussain *et al.*, 2022)(Acharya & Rajendran, 2023; Mantai & Marrone, 2022)
3.	Communication	39	(Tinkler and Jackson, 2002; Winston and Fields, 2003; Gilbert *et al.*, 2004; Craswell, 2007; Manathunga, Pitt and Critchley, 2009; Saunders, 2009; Wiles *et al.*, 2009; Ferguson, 2009; McAlpine and Asgharb, 2010; Mowbray and Halse, 2010; Mullen, Fish and Hutinger, 2010; Walsh *et al.*, 2010; Garcia-Perez and Ayres, 2012; Lean, 2012; Platow, 2012; Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Disney *et al.*, 2013; Hancock and Walsh, 2014; Jackson and Michelson, 2014; Smith *et al.*, 2014; Buss *et al.*, 2014; Moore and Morton, 2015; Dash, 2015; Shmatko, 2016; Barnard, Mallaband and Leder Mackley, 2018; Germain-Alamartine and Moghadam-Saman, 2019; Jackson, Milos and Kerr, 2019; Molla and Cuthbert, 2019; Muñoz, Guerra and Mosey, 2019; Candy, Rodrigo and Turnbull, 2019; Patterson *et al.*, 2020; Stewart-Wells and Keenan, 2020; Aguinis, Yu and Tosun, 2021; Mitic and Okahana, 2021; Sakurai and Pyhältö, 2021; Bromley and Warnock, 2021; Hussain *et al.*, 2022)(Mantai & Marrone, 2022)
4.	Writing skills	34	(Aguinis et al., 2021; Barnacle & Dall'Alba, 2013; Barnard et al., 2018; Blaj-Ward, 2011; Boddy, 2007; Bromley & Warnock, 2021; Burt et al., 2017; Buss et al., 2014; Candy et al., 2019; Ciampa & Wolfe, 2019; Craswell, 2007; Dash, 2015; Ferguson, 2009; Gilbert et al., 2004; Hussain et al., 2022; Lindner et al., 2001; Manathunga et al., 2009; Mitic & Okahana, 2021; Moore & Morton, 2015; Mowbray & Halse, 2010; Mullen et al., 2010; Park, 2005; Patterson et al., 2020; Pilbeam et al., 2013; Platow, 2012; Sakurai & Pyhältö, 2021; Saunders, 2009; Shmatko, 2016; Smith et al., 2014; Stewart-Wells & Keenan, 2020; Walsh et al., 2010; Winston & Fields, 2003) (Acharya & Rajendran, 2023; Mantai & Marrone, 2022)
5.	Teamwork/ Collaborative work	33	(Gilbert *et al.*, 2004; Craswell, 2007; Manathunga, Pitt and Critchley, 2009; Wiles *et al.*, 2009; McAlpine and Asgharb, 2010; Mowbray and Halse, 2010; Mullen, Fish and Hutinger, 2010; Walsh *et al.*, 2010; Blaj-Ward, 2011; Garcia-Perez and Ayres, 2012; Lean, 2012; Platow, 2012; Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Disney *et al.*, 2013; Hancock and Walsh, 2014; Jackson and Michelson, 2014; Smith *et al.*, 2014; Moore and Morton, 2015; Shmatko, 2016; Burt, Lundgren and Schroetter, 2017; Barnard, Mallaband and Leder Mackley, 2018; Germain-Alamartine, 2019; Molla and Cuthbert, 2019; Muñoz, Guerra and Mosey, 2019; Candy, Rodrigo and Turnbull, 2019; Ciampa and Wolfe, 2019; Patterson *et al.*, 2020; Mitic and Okahana, 2021; Bromley and Warnock, 2021; Sakurai and Pyhältö, 2021) (Dash, 2015) (Mantai & Marrone, 2022)
6.	Management (project/people/research)	32	(Lindner, Dooley and Murphy, 2001; Gilbert *et al.*, 2004; Craswell, 2007; Manathunga, Pitt and Critchley, 2009; Saunders, 2009; Wiles *et al.*, 2009; McAlpine and Asgharb, 2010; Mowbray and Halse, 2010; Walsh *et al.*, 2010; Blaj-Ward, 2011; Lean, 2012; Platow, 2012; Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Disney *et al.*, 2013; Hancock and Walsh, 2014; Jackson and Michelson, 2014; Smith *et al.*, 2014; Shmatko, 2016; Barnard, Mallaband and Leder Mackley, 2018; Germain-Alamartine, 2019; Germain-Alamartine and Moghadam-Saman, 2019; Jackson, Milos and Kerr, 2019; Molla and Cuthbert, 2019; Candy, Rodrigo and Turnbull, 2019; Patterson *et al.*, 2020; Mitic and Okahana, 2021; Sakurai and Pyhältö, 2021; Bromley and Warnock, 2021; Hussain *et al.*, 2022)(Acharya & Rajendran, 2023; Mantai & Marrone, 2022)
7.	Awareness	28	(Tinkler and Jackson, 2002; Gilbert *et al.*, 2004; Craswell, 2007; Manathunga, Pitt and Critchley, 2009; Saunders, 2009; Wiles *et al.*, 2009; Mullen, Fish and Hutinger, 2010; Walsh *et al.*, 2010; Blaj-Ward, 2011; Lean, 2012; Garcia-Perez and Ayres, 2012; Barnacle and Dall'Alba, 2013; Ulrich and Dash, 2013; Disney *et al.*, 2013; Smith *et al.*, 2014; Moore and Morton, 2015; Shmatko, 2016; Burt, Lundgren and Schroetter, 2017; Jackson, Milos and Kerr, 2019; Candy, Rodrigo and Turnbull, 2019; Ciampa and Wolfe, 2019; Germain-Alamartine, 2019; Patterson , 2020; Stewart-Wells and Keenan, 2020; Mitic and Okahana, 2021; Sakurai and Pyhältö, 2021; Hussain *et al.*, 2022)(Mantai & Marrone, 2022)

8.	Thinking ability	24	(Barnacle & Dall'Alba, 2013; Burt et al., 2017; Ciampa & Wolfe, 2019; Dash, 2015; Ferguson, 2009; Hussain et al., 2022; D. Jackson & Michelson, 2014; Lindner et al., 2001; McAlpine & Asgharb, 2010; Molla & Cuthbert, 2019; Moore & Morton, 2015; Mowbray & Halse, 2010; Mullen et al., 2010; Muñoz et al., 2019; Patterson et al., 2020; Stewart-Wells & Keenan, 2020; Ulrich & Dash, 2013; Winston & Fields, 2003)(Bromley & Warnock, 2021; Shmatko, 2016)(Lean, 2012; Manathunga et al., 2009; Smith et al., 2014)(Mantai & Marrone, 2022)
9.	Networking	23	(Manathunga, Pitt and Critchley, 2009; Saunders, 2009; Ferguson, 2009; Mullen, Fish and Hutinger, 2010; Walsh *et al.*, 2010; Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Disney *et al.*, 2013; Smith *et al.*, 2014; Hancock and Walsh, 2014; Jackson and Michelson, 2014; Shmatko, 2016; Barnard, Mallaband and Leder Mackley, 2018; Jackson, Milos and Kerr, 2019; Molla and Cuthbert, 2019; Ciampa and Wolfe, 2019; Germain-Alamartine, 2019; Germain-Alamartine and Moghadam-Saman, 2019; Bromley and Warnock, 2021; Mitic and Okahana, 2021; Sakurai and Pyhältö, 2021)(Acharya & Rajendran, 2023; Mantai & Marrone, 2022)
10.	Problem solving	22	(Gilbert *et al.*, 2004; Craswell, 2007; Mullen, Fish and Hutinger, 2010; Lean, 2012; Platow, 2012;Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Smith *et al.*, 2014; Hancock and Walsh, 2014; Jackson and Michelson, 2014; Moore and Morton, 2015; Shmatko, 2016; Candy, Rodrigo and Turnbull, 2019; Molla and Cuthbert, 2019; Muñoz, Guerra and Mosey, 2019;Jackson, Milos and Kerr, 2019; Patterson *et al.*, 2020; Stewart-Wells and Keenan, 2020; Bromley and Warnock, 2021; Mitic and Okahana, 2021; Hussain *et al.*, 2022)(Mantai & Marrone, 2022)
11.	Decision making	21	(Lindner, Dooley and Murphy, 2001; Tinkler and Jackson, 2002;Craswell, 2007; Ferguson, 2009; Mowbray and Halse, 2010; Walsh *et al.*, 2010; Blaj-Ward, 2011; Lean, 2012; Ulrich and Dash, 2013; Hancock and Walsh, 2014; Smith *et al.*, 2014; Buss *et al.*, 2014; Moore and Morton, 2015; Jackson, Milos and Kerr, 2019; Molla and Cuthbert, 2019; Ciampa and Wolfe, 2019; Patterson *et al.*, 2020; Aguinis, Yu and Tosun, 2021; Bromley and Warnock, 2021; Sakurai and Pyhältö, 2021)(Mantai & Marrone, 2022)
12.	Ethics/ integrity	20	(Blaj-Ward, 2011; Bromley & Warnock, 2021; Buss et al., 2014; Ciampa & Wolfe, 2019; Craswell, 2007; Dash, 2015; Gilbert et al., 2004; Hancock & Walsh, 2014; Hussain et al., 2022; Mowbray & Halse, 2010; Mullen et al., 2010; Park, 2005; Patterson et al., 2020; Sakurai & Pyhältö, 2021; Saunders, 2009; Smith et al., 2014; Ulrich & Dash, 2013; Winston & Fields, 2003)(Manathunga et al., 2009; Shmatko, 2016)(Mantai & Marrone, 2022)
13.	Leadership	20	(Bromley & Warnock, 2021; Burt et al., 2017; Candy et al., 2019; Craswell, 2007; Dash, 2015; Disney et al., 2013; Gilbert et al., 2004; C. Jackson et al., 2019; Manathunga et al., 2009; McAlpine & Asgharb, 2010; Mitic & Okahana, 2021; Mowbray & Halse, 2010; Mullen et al., 2010; Patterson et al., 2020; Platow, 2012; Sakurai & Pyhältö, 2021; Saunders, 2009; Shmatko, 2016; Stewart-Wells & Keenan, 2020; Ulrich & Dash, 2013)(Mantai & Marrone, 2022)
14.	Creativity/creative/creatively	20	(Aguinis et al., 2021; Bromley & Warnock, 2021; Gilbert et al., 2004; Hancock & Walsh, 2014; Hussain et al., 2022; Manathunga et al., 2009; Molla & Cuthbert, 2019; Moore & Morton, 2015; Mowbray & Halse, 2010; Mullen et al., 2010; Muñoz et al., 2019; Park, 2005; Patterson et al., 2020; Platow, 2012; Shmatko, 2016; Smith et al., 2014; Ulrich & Dash, 2013)(Acharya & Rajendran, 2023; Mantai & Marrone, 2022) (Lean, 2012)
15.	Teaching	19	(Aguinis et al., 2021; Barnard et al., 2018; Blaj-Ward, 2011; Boddy, 2007; Burt et al., 2017; Buss et al., 2014; Candy et al., 2019; Dash, 2015; Ferguson, 2009; Gilbert et al., 2004; Hussain et al., 2022; Manathunga et al., 2009; Mitic & Okahana, 2021; Mowbray & Halse, 2010; Mullen et al., 2010; Park, 2005; Platow, 2012; Saunders, 2009; Wiles et al., 2009)(Mantai & Marrone, 2022)
16.	Entrepreneurship/Entrepreneurialism/Entrepreneurial skills	17	(Bromley & Warnock, 2021; Candy et al., 2019; Craswell, 2007; Germain-Alamartine, 2019; Germain-Alamartine & Moghadam-Saman, 2019; Gilbert et al., 2004; Hancock & Walsh, 2014; Lean, 2012; Mitic & Okahana, 2021; Molla & Cuthbert, 2019; Muñoz et al., 2019; Patterson et al., 2020; Sakurai & Pyhältö, 2021; Shmatko, 2016; Smith et al., 2014; Walsh et al., 2010)(Mantai & Marrone, 2022)
17.	Motivation	17	Saunders, 2009; Ferguson, 2009; Walsh *et al.*, 2010; Mowbray and Halse, 2010; Mullen, Fish and Hutinger, 2010; Pilbeam, Lloyd-Jones and Denyer, 2013; Ulrich and Dash, 2013; Disney *et al.*, 2013; Smith *et al.*, 2014; Buss *et al.*, 2014; Jackson and Michelson, 2014; Barnard, Mallaband and Leder Mackley, 2018; Ciampa and Wolfe, 2019; Bromley and Warnock, 2021; Hussain *et al.*, 2022)(Acharya & Rajendran, 2023; Mantai & Marrone, 2022)
18.	Time Management/Timely	17	(Acharya & Rajendran, 2023; Aguinis et al., 2021; Barnacle & Dall'Alba, 2013; Barnard et al., 2018; Bromley & Warnock, 2021; Ciampa & Wolfe, 2019; Gilbert et al., 2004; Hancock & Walsh,

			2014; Hussain et al., 2022; D. Jackson & Michelson, 2014; Lindner et al., 2001; Manathunga et al., 2009; Mantai & Marrone, 2022; Park, 2005; Platow, 2012; Shmatko, 2016; Smith et al., 2014)
19.	Language skills	15	(Blaj-Ward, 2011; Burt et al., 2017; Ciampa & Wolfe, 2019; Garcia-Perez & Ayres, 2012; Germain-Alamartine & Moghadam-Saman, 2019; Gilbert et al., 2004; Hussain et al., 2022; Moore & Morton, 2015; Park, 2005; Pilbeam et al., 2013; Platow, 2012; Sakurai & Pyhältö, 2021; Shmatko, 2016; Tinkler & Jackson, 2002; Ulrich & Dash, 2013) (Mantai & Marrone, 2022)
20.	Confidence	15	(Acharya & Rajendran, 2023; Boddy, 2007; Bromley & Warnock, 2021; Buss et al., 2014; Candy et al., 2019; Dash, 2015; Ferguson, 2009; Lean, 2012; McAlpine & Asgharb, 2010; Mowbray & Halse, 2010; Mullen et al., 2010; Smith et al., 2014; Stewart-Wells & Keenan, 2020; Tinkler & Jackson, 2002; Walsh et al., 2010)
21.	Multidisciplinary/Interdisciplinary	11	(Bromley & Warnock, 2021; Hancock & Walsh, 2014; Manathunga et al., 2009; Patterson et al., 2020; Platow, 2012; Saunders, 2009; Shmatko, 2016; Ulrich & Dash, 2013)(Acharya & Rajendran, 2023; Mantai & Marrone, 2022)(Gilbert et al., 2004)
22.	Digital skills/Software/IT Tools	11	(Barnard et al., 2018; Candy et al., 2019; Hussain et al., 2022; Patterson et al., 2020; Sakurai & Pyhältö, 2021; Ulrich & Dash, 2013; Wiles et al., 2009)(Acharya & Rajendran, 2023; Mantai & Marrone, 2022) (Gilbert et al., 2004)(Manathunga et al., 2009)
23.	Judgement	07	(Hancock & Walsh, 2014; C. Jackson et al., 2019; Lean, 2012; Manathunga et al., 2009; Moore & Morton, 2015; Park, 2005; Smith et al., 2014)
24.	Adaptability/Adaptable	07	(Ulrich and Dash, 2013; Moore and Morton, 2015; Shmatko, 2016; Germain-Alamartine and Moghadam-Saman, 2019; Molla and Cuthbert, 2019; Patterson *et al.*, 2020; Bromley and Warnock, 2021)
25.	Ability to self-assess/reflective/reflecting competency/self-reflection/reflectivity	06	(Buss et al., 2014; (Ulrich & Dash, 2013) Manathunga et al., 2009; Mowbray & Halse, 2010; Smith et al., 2014) (Molla & Cuthbert, 2019)
26.	Open mind/Openness/Open	06	(Germain-Alamartine & Moghadam-Saman, 2019; Gilbert et al., 2004; Lean, 2012; Shmatko, 2016; Ulrich & Dash, 2013)(Acharya & Rajendran, 2023)
27.	Learner	05	(Craswell, 2007; Mullen, Fish and Hutinger, 2010; Buss *et al.*, 2014; Barnard, Mallaband and Leder Mackley, 2018; Patterson *et al.*, 2020)
28.	Achievement/Achievement orientation	05	(Lean, 2012; Lindner et al., 2001; Molla & Cuthbert, 2019; Platow, 2012)(Acharya & Rajendran, 2023)
29.	Commercialise an idea/commercialise research/commercialisation	04	(Lean, 2012; Mantai & Marrone, 2022; Sakurai & Pyhältö, 2021; Smith et al., 2014)
30.	Formulating research problem/ Problem identification/ Formulate statement of the problem/Identifying a researchable question or problem	04	(Hussain et al., 2022; Lindner et al., 2001; Shmatko, 2016; Winston & Fields, 2003)
31.	Persuasive/ Persuasion/ Persuasively	04	(Lindner, Dooley and Murphy, 2001; Ciampa and Wolfe, 2019; Muñoz, Guerra and Mosey, 2019; Mitic and Okahana, 2021)
32.	Laboratory skills /laboratory work/laboratory/	03	(Mowbray & Halse, 2010; Sakurai & Pyhältö, 2021; Shmatko, 2016)
33.	Perseverance	03	(Lean, 2012; Mantai & Marrone, 2022; Mullen et al., 2010)
34.	Quality documentation/Skills documentation	02	(Mantai & Marrone, 2022; Shmatko, 2016)
35.	Act autonomously/autonomous	02	(Lean, 2012; Park, 2005)

The ranking and details of the following skills based on this synthesis, from highest to lowest, are mentioned below:

Knowledge (47): Interestingly, discipline-specific and research knowledge was found to be the most relevant skill that can be utilized by a doctoral researcher for formulating research problems, writing the thesis, developing a research plan, and disseminating knowledge through teaching and presentations (Molla and Cuthbert, 2019; Muñoz, Guerra and Mosey, 2019).

Identify/create/take/seek opportunities (40): The

development of a doctoral researcher's personality and their preparation for participation in the workforce can be contributed to by skill development courses, grant applications, and conference paper presentations (Gilbert et al., 2004; Park, 2005).

Communication (39): Most researchers are found to lack communication skills, which are considered a form of experiential learning. Networking, presentation, collaboration, and the ability to sell their research idea can be enabled by these skills (Mowbray and Halse, 2010; Mullen, Fish and Hutinger, 2010).

Writing skills (34): Healthy writing practices in students can be developed with the assistance of thesis writing groups and constructive feedback, which are essential for research publication, requiring analysis and formulation of arguments in doctoral studies (Hussain et al., 2022; Lindner et al., 2001).

Teamwork/collaborative work (33): Networking and quality research are promoted, and multidisciplinary competencies are built by collaborating with colleagues and engaging in trans-sectoral collaboration (Lean, 2012; Platow, 2012).

Management (project/ people /research) (32): Successful completion of the study is ensured by researchers who manage research projects, ensure timely completion, manage people involved in projects, and collaborate with other agencies or colleagues (Lindner, Dooley and Murphy, 2001; Gilbert et al., 2004).

Awareness (28): Awareness of available opportunities, preparation for current job markets outside academia, and understanding of research and different academic styles are considered important for a researcher (Saunders, 2009; Wiles et al., 2009).

Thinking ability (24): Analyzing and interpreting research objectively and generating original research ideas can be facilitated by critical thinking (Barnacle & Dall'Alba, 2013; Burt et al., 2017).

Networking (23): Employment outcomes can be influenced, research can be expanded, interdisciplinary research can be encouraged, and collaboration can be advanced through networking (Germain-Alamartine, 2019; Germain-Alamartine and Moghadam-Saman, 2019).

Problem solving (22): Problem-solving related to research, such as methodology and data collection, is expected of a researcher, along with solving other real-world problems (Jackson and Michelson, 2014; Moore and Morton, 2015).

Decision making (21): When faced with uncertainties, research related decisions are expected to be taken by a researcher to ensure completion of PhD (Ferguson, 2009; Mowbray and Halse, 2010).

Ethics/integrity (20): The quality of research is guided by ethics, which encompass avoiding plagiarism, bias, copyright infringement, and intellectual property rights issues (Ulrich & Dash, 2013; Winston & Fields, 2003).

Leadership (20): In academia, leadership is required to mentor students, handle groups, and take initiative (Bromley & Warnock, 2021; Burt et al., 2017).

Creativity/creative/creatively (20): Creative problem-solving and the application of research skills and knowledge to generate innovative ideas are expected from researchers (Aguinis et al., 2021; Bromley & Warnock, 2021).

Teaching (19): The ability to handle the teaching workload and possess good teaching skills to disseminate knowledge to students from different cultural backgrounds is expected from a researcher (Manathunga et al., 2009; Mitic & Okahana, 2021).

Entrepreneurship/entrepreneurialis m/entrepreneu rial skills (17): Efficient researchers are expected to have entrepreneurial intentions to apply research to start a business, collaborate with industries, and create an enterprise by making a profit (Molla & Cuthbert, 2019; Muñoz et al., 2019).

Motivation (17): Strong intrinsic and extrinsic motivation to learn new things, adapt to new situations, face challenges on their own, and make the most of the available opportunities are expected (Smith et al., 2014; Buss et al., 2014).

Time Management/time/timely (17): To be professional, research projects and assignments must be completed timely, with deadlines strictly adhered to (Mantai & Marrone, 2022; Park, 2005).

Language skills (15): Knowledge of foreign languages especially English can help a researcher

overcome linguistic incompetence and publish papers that are globally accepted and contribute to the discourse at the global level. Public speaking skills will be imbibed by a researcher through this (Blaj-Ward, 2011; Burt et al., 2017).

Confidence (15): Confidence is required by a researcher who faces multiple rejections in publishing papers and is expected to constantly make changes to their writing, presentation, and personality during the course of research (Smith et al., 2014; Stewart-Wells & Keenan, 2020).

Multidisciplinary /interdisciplinary (11): Multidisciplinary/interdisciplinary research can be pursued by a researcher to expand their research problem and contribute to solving real-world problems (Patterson et al., 2020; Platow, 2012).

Digital skills/Software/IT Tools (11): The results can be validated and accuracy can be provided to the results by using software such as Nvivo/SPSS for data analysis and other technology-assisted research tools (Hussain et al., 2022; Patterson et al., 2020).

Judgement (07): Researchers are expected to have the ability to weigh the pros and cons of a situation and make decisions accordingly (Park, 2005; Smith et al., 2014).

Adaptability/adaptable (07): Being able to adapt to different situations and work efficiently is expected of a researcher due to the uncertainty of research (Ulrich and Dash, 2013; Moore and Morton, 2015).

Ability to self-assess/ reflective/ reflecting competency/ self-reflection/ reflectivity (06): One's strengths, weaknesses, and developmental gaps should be reflected upon to create an identity and foster awareness of their careers (Buss et al., 2014; .

Open minded/openness/open (06): Higher completion rates of PhDs can be ensured by staying open to different viewpoints, constructive feedback, and uncertainties of research (Gilbert et al., 2004; Lean, 2012; Shmatko, 2016).

Learner (05): Responsibility to learn more about research and fulfill research goals instead of relying on their supervisor is expected of a researcher as a lifelong learner (Barnard, Mallaband and Leder Mackley, 2018; Patterson et al., 2020).

Achievement/achievement orientation (05): Achievement orientation for a researcher is incorporated by the desire to set goals, having plans to achieve those goals, and having a vision incorporates achievement orientation for a researcher (Lindner et al., 2001; Molla & Cuthbert, 2019).

Commercialise an idea/ commercialise research/ commercialisation (04): The ability to commercialize research output and build a startup or engage in industrial work is deemed important for a researcher in a global world (Sakurai & Pyhältö, 2021; Smith et al., 2014).

Formulating research problem/ Problem identification/formulate statement of the problem/identifying a researchable question or problem (04): Research is expected to be initiated by a researcher through the identification of a relevant research problem, followed by the presentation of the problem in the form of research questions or objectives after conducting an extensive literature review (Hussain et al., 2022; Lindner et al., 2001).

Persuasive/persuasion/persuasively (04): Communication of the validity and significance of one's research to experts and the acquisition of funding and collaboration opportunities can be facilitated by the ability to express ideas persuasively in oral and written communication (Lindner, Dooley and Murphy, 2001; Ciampa and Wolfe, 2019).

Laboratory skills/laboratory work/laboratory (03): Workshop and laboratory skills are typically expected to be possessed by STEM researchers to perform experiments and efficiently utilize instruments to produce research output (Mowbray & Halse, 2010; Sakurai & Pyhältö, 2021).

Perseverance (03): The attrition rate in PhD can be reduced by perseverance and the ability to persist amidst criticism and rejections (Lean, 2012; Mantai & Marrone, 2022).

Quality documentation/skills documentation (02): Quality drafts and preliminary feasibility studies for research projects and studies should be provided by a researcher for record (Mantai & Marrone, 2022; Shmatko, 2016).

Act autonomously/autonomous (02): This attribute enables calculated risks to be taken and rational

decisions to be made based on the researcher's own knowledge and experience, followed by conviction in implementing the decision, without reliance on their supervisor, yielding results (Lean, 2012; Park, 2005).

B. Sample Size

The phrases such as doctoral researcher's skills or employability skills, generic skills, research skills, and transferable skills have frequently been used in the papers included in the study to explore these ideas, and occasionally, these terms have also been used interchangeably. A substantial correlation between doctoral researchers' employability and skills has been found in the majority of studies. Additionally, a substantial association between doctoral researcher's abilities and the successful completion of PhD has been established in many studies. A graphical representation of the sample size employed in these studies is provided in Figure 3 for further clarity.

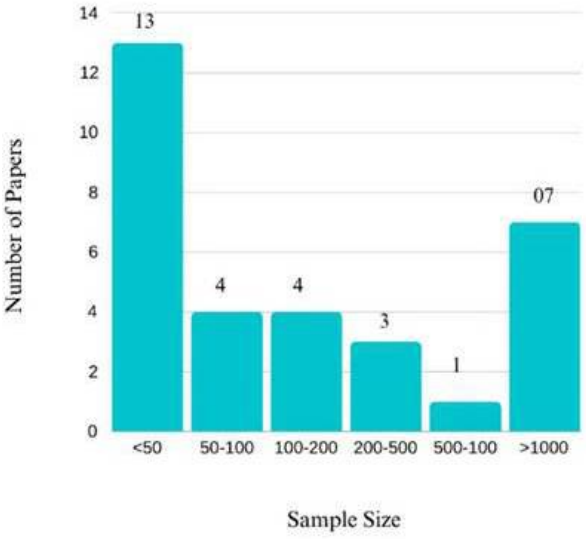

Fig 3 : Graphical depiction of sample size of SLR studies

From the 48 articles taken into consideration for this SLR, 32 research papers included in this study have a sample size ranging from lower than 50 to more than 1000. There were 13 research papers (40%) with fewer than 50 participants as a sample, 4 research papers (12%) with samples ranging from 50 to 100, 4 research papers (12%) with a sample size above 100 to 200, 3 papers (9%) with a sample size ranging from above 200 to 500, 1 paper with a sample size ranging from above 500 to 1,000, and 7 research papers (21%) with a sample size of more than 1,000.

The summary of the studies included in this study is displayed in Table IV below:

Table 4:
Summary of Studies included in Systematic Literature Review

Sr. No.	Author / Year	Methods /Techniques	Measurement Scale / Analysis	Country / Region	Respondent	Sample Size
1	(Mitic & Okahana, 2021)	Survey Questionnaire, Regression, correlation	Five-point Likert scale	USA	Early career PhD alumni from 50 US institutions	2400
2	(Aguinis et al., 2021)	General review	NA	USA	Researchers, students, Practitioners, policy makers	NA
3	(Candy et al., 2019)	Focus Groups, Snowball sampling approach	Thematic analysis	UK	Doctoral student, two part time and nine full time	11
4	(Mowbray & Halse, 2010)	In-depth semi-Structured interviews	Grounded Theory	Australia	Doctoral students	21
5	(Ulrich & Dash, 2013)	General discussion and viewpoint	Summary of Apec and Deloitte report	Finland, France, Germany, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States	Senior researchers, Research Managers	NA
6	(Garcia-Perez & Ayres, 2012)	Structured Interviews	Qualitative, Coding scheme	UK	PhD students and PhD holders	22
7	(Barnard et al., 2018)	Detailed qualitative questionnaire	Detailed analysis	UK	Research trainer sand organisers	223
8	(Gilbert et al., 2004)	Theoretical	NA	US,UK Australia	Doctoral researchers	NA
9	(Sakurai & Pyhältö, 2021)	Online survey	Exploratory and confirmatory factor analysis, principal component analysis and heatmap analyses	Finland	Doctoral students	1184
10	(Disney et al., 2013)	Reflective focus groups, feedback questionnaire	Detailed analysis	UK	Doctoral researchers academic and non-academic attendees	116
11	(Barnacle & Dall'Alba, 2013)	Theoretical	NA	Australia	Doctoral researchers	NA

12	(Blaj-Ward, 2011)	Case study	Observation and discussion notes, email interaction and document analysis, Nvivo	UK	Doctoral researchers	Not clearly defined
13	(Hancock & Walsh, 2014)	Theoretical	NA	UK	Doctoral Researchers	NA
14	(Smith et al., 2014)	Electronic Survey	Correlation test	UK	Doctoral researchers, Master's students	100
15	(Walsh et al., 2010)	Questionnaire	Non parametric tests, Statistical analysis using SPSS	UK	Doctoral researchers	1000
16	(Moore & Morton, 2015)	Discourse based semi structured interviews	Thematic analysis	Australia	Managers and supervisors	20
17	(Saunders, 2009)	Mixed, Feedback forms	Thematic analysis	UK	Research scholars, Staff	74
18	(Wiles et al., 2009)	Survey questionnaire	Content analysis, descriptive statistics	UK	PhD students, directors of research centres	448 students 58 Employers
19	(Winston & Fields, 2003)	Individual interviews	Detailed analysis	UK	Faculty	Not clearly defined
20	(Craswell, 2007)	Theoretical	Synopsis of researchers meeting	Australia	Doctoral students	NA
21	(Ferguson, 2009)	Feedback forms Qualitative	Thematic analysis	Jamaica	Doctoral students	20
22	(Buss et al., 2014)	Mixed method design, online questionnaire	Five point Likert scale	USA	Doctoral students	32 Quantitative, 18 qualitative
23	(Bromley & Warnock, 2021)	Review Paper	Existing literature reviewed		Doctoral students	NA
24	(Patterson et al., 2020)	Conceptual paper	Current education models reviewed			NA
25	(Tinkler & Jackson, 2002)	Mixed method:Interview and questionnaire	Thematic analysis	UK	Doctoral students, examiner, Supervisors	100 examiners,42 supervisors, 88students, 35 students qualitative
26	(Stewart-Wells & Keenan, 2020)	Feedback forms	Anecdotal evidence	UK	Doctoral students	45
27	(Shmatko, 2016)	Mixed method, Data collected from two empirical studies,in depth interviews	Five point Likert scale	Russia	Doctoral students, experts	1884 PhD holders ,30 experts
28	(Park, 2005)	Theoretical	Charts the origins of PhD in UK			NA
29	(Germain-Alamartine & Moghadam-Saman, 2019)	Exploratory and Comparative Case study. Semi structured interviews	Analysis using Nvivo	Sweden	Doctoral student, faculty, employers	17
30	(Lean, 2012)	Electronic survey, questionnaire	Non parametric test, paired sample sign test	UK	Research scholars	128
31	(Muñoz et al., 2019)	Multiple case study research design	Thematic analysis, empirical scrutiny	Chile	Research scholars	13
32	(Germain-Alamartine, 2019)	Case study	Exploratory, Descriptive statistics	Catalonia	PhD holders	1358 students, 1325 employers
33	(Molla & Cuthbert, 2019)	Survey	Critical analysis	Australia	Universities	Not clearly defined
34	(Pilbeam et al., 2013)	Semi structured interviews	Qualitative analysis, coding, MAXQDA	UK	Doctoral researchers	17
35	(D. Jackson & Michelson, 2014)	National Survey	Logistic regression, Statistical Analysis SPSS	Australia	PhD graduates	5942
36	(Boddy, 2007)	Theoretical	Viewpoint on the past studies			NA
37	(Manathunga et al., 2009)	Pilot study: open ended questionnaire with both qualitative and quantitative questions	Five point Likert scale	Australia	Research graduates	115
38	(Mullen et al., 2010)	Electronic interviews; audio-taped conversations; reflection journals; email communications; and written assignments	Qualitative analysis, coding, thematic analysis	USA	Students	12

39	(Dash, 2015)	Theoretical, viewpoint	Comparing and contrasting the state of research er in Indian and Malaysia	India, Malaysia	Doctoral students	NA
40	(C. Jackson et al., 2019)	Baseline, pulse and final survey	Qualitative analysis	Australia	Doctoral students	90 mentees, 47 students
41	(Hussain et al., 2022)	Quantitative questionnaire, non-random sampling technique	Descriptive and inferential statistics ,SPSS	Pakistan	Doctoral students	394
42	(Burt et al., 2017)	Longitudinal case study, focus group interviews	Thematic analysis	USA	Doctoral students	04
43	(Lindner et al., 2001)	Mixed mailed/Internet questionnaire	SPSS	USA	Doctoral students	39
44	(Platow, 2012)	Questionnaire, online structured survey	Linear regression, binomial logistic regression	Australia	Doctoral students	1258
45	(McAlpine & Asgharb, 2010)	Online survey, feedback forms, focus groups	Qualitative analysis	North America	Doctoral students, faculty	Not clearly defined
46	(Ciampa & Wolfe, 2019)	Qualitative open ended online survey	Axial and selective coding, thematic analysis, Content analysis, descriptive statistics	USA	Doctoral students	115
47	(Mantai & Marrone, 2022)	Data driven approach to taxonomy building	Logistic regression analysis	40 European and Non-European countries	PhD advertisements	13,562
48	(Acharya & Rajendran, 2023)	Conceptual Paper	Existing literature reviewed	NA	Doctoral researchers	68 research articles

C. Methodology adopted by studies included in SLR

The selected 48 studies were comprised of 12 theoretical and 36 empirical studies. Out of the 36, a quantitative approach (mostly pre-determined closed-ended questionnaires) in the form of structured survey questionnaires to analyze skills for doctoral researchers using correlation tests and five-point Likert scales was utilized by 11 studies. On the contrary, qualitative methods of data collection and analysis were adopted by around 20 studies, which included semi-structured questionnaires, case studies, focus groups, and data collected through feedback forms. Content analysis and thematic analysis using coding were found to be the most popular methods of data analysis.

Interestingly, a triangulation method was adopted by only 05 papers. A validated or study-specific questionnaires, semi-structured interviews, or both were used by some studies to assess the important skills for PhD researchers. Furthermore, no predetermined standard sample size was found to be incorporated in the qualitative and quantitative studies that would enable a thorough analysis. Suitable software programs, especially Nvivo, SPSS, VoS, or AMOS, have not been utilized in many studies for qualitative and quantitative studies. In fact, the sample size of their study has not been clearly mentioned in 04 empirical studies, which accounts for inadequate data.

4. Discussion Of The Findings

The concept of researcher development and works on researcher development were explored in the earlier review study conducted on doctoral researchers by Bromley and Warnock (2021). A few studies and competency models were cited by this study to develop these skills and explained the significance of the said topic. However, the skills for doctoral researchers were investigated in this SLR study based on published empirical and theoretical research studies. The systematic literature review approach, as followed by Ahmed et al. (2021) in their study titled "Systematic literature review of project manager's leadership competencies," was followed to come up with a robust systematic review paper on skills for doctoral researchers. A significant amount of time was spent on determining the popularity of the researcher's skills in the selected studies for this SLR. An ambiguity in the use of words, such as generic skills, transferable skills, professional skills, employability skills, soft skills, etc., that have been used frequently in the literature in the context of doctoral researcher's skills was highlighted by this SLR. In the literature on skills for doctoral researchers, there is no clear distinction between which skills can be referred to as generic skills and which can be considered transferable skills, and these terms have been used interchangeably. (Craswell, 2007). However, it has been maintained by several studies that these words mean the same, and therefore they have been used interchangeably (Bromley &

Warnock, 2021; Craswell, 2007). Therefore, all skills have been considered while preparing this study.

According to a number of studies in the SLR, doctoral researcher's skills are commonly associated with the successful completion of a PhD and with the acquisition of jobs (Mantai & Marrone, 2022; Sakurai & Pyhältö, 2021). Skills such as technical writing and communication can be acquired by doctoral researchers to convey their research to the academic world and establish rapport with their supervisors and peers, which can further facilitate networking and collaboration for research (Hussain et al., 2022; Moore & Morton, 2015).

Three main objectives have been addressed by the findings of this study. A consolidated list of 35 skills, such as ethics, communication, and management skills for doctoral researchers, along with their rankings, was developed to address the dearth of a list on this topic.

Then, the limitations of the research techniques and sample sizes of the papers incorporated in SLR were identified. Additionally, 36 empirical studies and 12 theoretical studies were included in this study. It was highlighted in Table 4 that around 20 empirical studies relied on thematic analysis and qualitative research as methods of assessment, which reduces the reliability and validity of the findings. Analysing the sample size in this review study. illustrated that around 65% of empirical studies included had a sample size upto 200 (Figure 3). To maximize the generalizability of findings and obtain sophisticated results, it is advised to use a sample size of 300 or more for quantitative studies on researcher development in future (Ahmed et al., 2021). Furthermore, perceptions of only doctoral students were addressed in around 23 empirical studies. The perceptions of either the supervisor or the recruiters have been incoporated by only a few studies, as shown in Table 4. Based on the research findings from this study, important implications for academics and doctoral researchers have been synthesized. The existing gap was addressed by enabling a structured analysis, and offering a critical overview of findings that are pertinent to doctoral researchers in the comprehensive review of literature presented here.

A. Implications for the stakeholders

The findings of this study can be utilized in future research and educational organizations to raise awareness regarding skills development for doctoral researchers. A self-improvement plan can be developed by researchers as they are increasingly aware of the skills expected of them. Doctoral researchers can be prepared to efficiently face challenges of a PhD by taking responsibility for their own research and successfully completing their PhD. Adoption of these skills can also help a student maintain his mental and emotional health as a skilled student will better adapt to different situations and cope with the stress of the PhD. Academics and policy makers can be helped by the study to design, develop, and introduce courses and programs that expose researchers to these skills, which will further increase the employability of the researchers in academia and industry. Future research and educational leaders can be developed with the help of this study.

B. Limitations of the study

Although a strict procedure was followed for conducting this SLR, the measuring techniques, study designs, and the outcomes of SLR, these investigations have significant drawbacks. This SLR has been restricted to looking through peer-reviewed, English-language, indexed journals that are present in the selected databases. Some of the conclusions drawn in this SLR may be refuted or supplemented by research studies on PhD researchers' skills that have been published in other languages. In future research, consideration should be given to applying the SLR approach to examine the different skills needed by PhD researchers in different fields, such as the humanities, sciences, management, etc. Additionally, thematic analysis and qualitative research were relied upon as methods of assessment by the majority of empirical studies, which reduces the reliability and validity of the findings. Additionally, not much has been done to demarcate different skills needed for different disciplines.

C. Future scope of the study

Due to ambiguity regarding different skills such as generic, transferable, soft skills, etc., it is essential that these words be used properly by researchers to avoid ambiguity when preparing a SLR in the future. An autonomous or independent SLR of both theoretical and empirical studies may be considered a useful area for future studies. Additionally, it is proposed that a mixed method approach be employed, enabling triangulation and offering a scientifically valid methodology to be utilized in future research

investigations. It is suggested that future research studies adopt both data as well as method triangulation and take into account the perceptions of the major stakeholders involved in the process, namely, the doctoral researchers, supervisors, recruiters, and policy makers in future studies in this area.

Conclusion

The synthesis of doctoral researcher's skills has revealed that writing skills, subject knowledge, communication, and ethics are sought after in a doctoral researcher as more than 30 studies have cited these skills as crucial for doctoral researchers as they are expected to pursue technical and academic writing, such as research papers, thesis, and dissertations, and to have good publications in order to have a successful career in academia. Simultaneously, it is important for the rules, regulations, and ethics of the profession to be abided by, and for malpractices such as plagiarism and unprofessional behavior to be avoided, as such actions can threaten one's career and have a domino effect on the reputation of the candidate's supervisor as well as the institution. In fact, 33 studies cited collaboration as a crucial skill that paves way for networking, expanding quality research. Similarly around 40% studies had a sample size below 50 and only 5 studies had adopted a triangulated approach. Adopting a bigger sample size, a triangulated approach will lend more credibility to the empirical studies in future. Imbibing the important skills by the doctoral researcher, while attrition and failure rates are decreased. Appendixes, if needed, appear before the acknowledgment.

Acknowledgment

Use the singular heading even if you have many acknowledgments. Leave this section as is for the double- blind review process.

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