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The role and understanding of empathy in entrepreneurial engineering: a systematic literature review

Aleksandr Litvinov , Anne Gardner , Sojen Pradhan  and Jeri Childers 

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ABSTRACT

This study reviews how empathy and its role are conceptualised in entrepreneurial and engineering literature. Our findings can then be used as a foundation for developing contextual and theoretical models of empathy for entrepreneurial engineering. These models will help create teaching practices and approaches to prepare empathic entrepreneurial engineers. The study deployed a systematic literature review of 40 papers from engineering and entrepreneurship fields, obtained from the Scopus and Web of Science databases. The analysis involved three phases. First, a descriptive analysis of research on empathy in entrepreneurship and engineering was completed, followed by a content analysis focusing on definitions and the role of the empathy phenomenon and a co-citation analysis to identify commonly cited authors. The results of this literature review demonstrate different indicators that reflect the current state of empathy research and study trajectories of this phenomenon in the fields of engineering and entrepreneurship. These indicators include the number of papers related to empathy in engineering and entrepreneurship literature by year of publication, definitions of empathy and keywords used in analysed literature as well as list of authors and their area of interests within empathy research.

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KEYWORDS

Entrepreneurship; empathy; engineering; technopreneurship

Entrepreneurship has many definitions, such as the ‘creation of a new enterprise’ (Low and MacMillan 1988; Low 2001); ‘process of extracting profits from new, unique, and valuable combinations of resources in an uncertain and ambiguous environment’ (Amit, Glosten, and Muller 1993); or creating jobs, opportunities, and economic growth in developed and developing countries (Barot 2015; Hessels and Naudé 2019). According to Beckman et al. (2012), technology entrepreneurship can be distinguished from the classic or mainstream entrepreneurship by considering its focus on the new opportunities promoted by innovations in technology and science. It can be broadly defined as the creation of new organisations or the transformation of existing ventures through the development and use of novel technologies (European Commission EC 2015). Engineering graduates play an integral role in creating modern technologies and tech startups (Baird 1992). Many academic papers and industry reports have noted the importance of the entrepreneurial skills and innovation capabilities of engineers (Nichols and Armstrong 2003; Duval-Couetil and Wheadon 2013; Karim 2016; Burnett et al. 2019). Creed, Suuberg, and Crawford (2002, 185) declared that an established environment and market demand ‘favours a new type of engineer, an entrepreneurial engineer, who needs a broad range of skills and knowledge, beyond a strong science and engineering background’. To meet entrepreneurial engineers’

demands, universities and other educational organisations design different entrepreneurial programs and courses to develop engineering students’ and graduates’ skills and abilities that help nascent entrepreneurs create and manage technology enterprises. However, Fayolle et al. (2021) added that it is essential to create unique educational models and approaches for teaching entrepreneurship to technical specialists, considering the difference in contextual characteristics of engineering and entrepreneurial activities.

The success of creating technology startups depends on many external and internal factors; one of the most essential elements is the entrepreneur’s competence (Gemmell, Boland, and Kolb 2012; Ezzedeen and Zikic 2012). To be actively engaged in the venture creation process, they should possess diverse and well-developed skills, knowledge, and competencies, such as opportunity identification (Shane 2000; Chell 2013); business and management (Loué and Baronet 2012); technical (Chang and Rieple 2013), personal, interpersonal, leadership (Hayton and Kelley 2006); and social skills (Baron and Tang 2009). Traditionally, social skills have been associated with networking, negotiation, and collaborative processes. However, after the introduction of new approaches and methods such as design-thinking or human-centred and empathetic design (Huq and Gilbert 2017), the role of certain social skills such as empathy

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expanded. For example, empathy might be considered as essential in terms of opportunity evaluation (Packard and Burnham 2021), product design (Leonard and Rayport 1997), creativity (Young 2015), and managing competitors (Ghezzi 2021). Some researchers and academicians observed that empathy and its related concepts, such as ‘empathetic accuracy’, play a primary role in determining the success of new technology ventures and startups (e.g. Chiles et al. 2010; McMullen 2015). However, Packard and Burnham (2021) stated that although entrepreneurship is “a process of solving others’ problems”, the influence of empathy on entrepreneurship has not yet been extensively researched.

Empathy is also highlighted as an essential professional skill for modern engineers (Penzenstadler et al. 2009). Developed empathic abilities can have numerous benefits in many different engineering processes, such as problem-solving and designing human experience (Kouprie and Visser 2009; Schmitt et al. 2016). Additionally, empathy in design activities can stimulate an innovation ‘spark’ (Leonard and Rayport 1997; Wachowicz et al. 2016). Moreover, different studies demonstrated that empathy could contribute to the formation of the following learning outcomes: effective team management (Köppen & Meinel, 2014), collaboration and communication (Walther, Miller, and Kellam 2012), and ethical decision-making and care (Levy and Hadar 2018). Given the importance of empathy in engineering, the number of studies conducted on it to formulate the relevant teaching practices and approaches has increased significantly (Bairaktarova et al. 2016; Hess, 2015; Hess & Fila, 2016a, 2016b; Hess et al. 2016b; Walther et al. 2020; Walther et al. 2017).

A common challenge in empathy research is to determine the variety of approaches that define and conceptualise this phenomenon. Titchener (1909) first presented the term ‘empathy’ as a translation of the German word ‘Einfühlung’, meaning ‘in-feeling’ or ‘feeling into’. However, over the last century, there have been many interpretations of this term; Cuff et al. (2016) identified 43 distinct summaries and definitions used in different fields. The authors also noted that it is a broad concept that depends on many contextual characteristics (Cuff et al. 2016). Since then, this topic has attracted increasing attention from researchers. Its generality has led to the recommendations for formulating unique empathy models for different contexts that take into consideration the features of different fields. However, Packard and Burnham (2021) concluded that despite the existence of many theories of empathy (e.g. Hoffman, 2000; Davis 2018), none meet the requirements of the contemporary entrepreneurship theory. Hence, there are many definitions and concepts of empathy. However, there are no well-established theories that determine

its role in entrepreneurial engineering and reflect the contextual features of this type of entrepreneurship.

This study aimed to conduct a systematic literature review to analyse how empathy is conceptualised in two fields: engineering and entrepreneurship. Examining these two contexts, the study attempts to create a foundation for future researchers to develop theories and empathy models in entrepreneurial engineering. According to Khan and Kumar (2019), it is important to pay attention to entrepreneurial ability and technological capability in the context of technology entrepreneurship. Hence, it is important to analyse empathy’s role in entrepreneurship and engineering to create empathy models for entrepreneurial engineering. These models can serve as the basis for forming learning practices and approaches aimed at developing empathy among the engineers aiming to become entrepreneurs. As a result, the following research question was formulated: ‘how does academic literature conceptualise the phenomenon of empathy in entrepreneurship and engineering?’

Materials and methods

Research methodology

This study followed the systematic literature review (SLR) process proposed by Tranfield, Denyer, and Smart (2003) to meet the study’s objectives and find transparent results that can be replicated. A systematic literature review is aimed at identifying and collecting relevant research papers on a chosen topic using systematic and replicable methods (Moher et al. 2009). A research approach was built on methodologies that were used in other literature reviews that explore social skills or entrepreneurial practices in the engineering field (Borrego, Foster, and Froyd 2014; Alam, Nasir, and Rehman 2020; Higuera Martínez, Fernández-Samacá, and Serrano Cárdenas 2021). In order to analyse data, descriptive analysis, content analysis and co-citation analysis were implemented. Firstly, the authors completed a descriptive analysis presenting simple summaries of data. This information provided the foundation for further content analysis aiming to synthesise results and connect them with theory. Then, the co-citation analysis was completed using the VOSviewer software. This section describes the SLR steps, the database search process, inclusion/exclusion criteria for papers, and the analysis procedures.

SLR procedure

As mentioned above, this study adopted the approach proposed by Tranfield, Denyer, and Smart (2003), which combined previous studies and offered three stages for conducting a systematic literature review.

- Stage One: planning the review, which includes identification and formulation of research purposes and questions and development of a review protocol. During this stage, the researchers involved in this review held a series of meetings to outline the goals, the phases of research and formulate the research question: how does academic literature conceptualise the phenomenon of empathy in entrepreneurship and engineering?
- Stage Two: conducting a review, which includes search and selection of studies, assessing the quality of papers and data selection. The database and search terms, selection criteria as well as searching and filtering process used in this study are described below. During this stage, the analysis of selected papers has been conducted that involved three phases which are: a descriptive analysis of research on empathy in entrepreneurship and engineering, a content analysis focusing on definitions and the role of the empathy phenomenon, and a co-citation analysis focused on identifying commonly cited authors.
- Stage Three: reporting and dissemination, which includes report writing and providing practical implications. During this stage, this article was written, as well as practical recommendations for research has been formulated. These recommendations were formed during a series of discussions with the researchers involved in this study.

The review protocol was developed in line with the recommendations of Tranfield, Denyer, and Smart (2003) to provide structure for this research. These stages represent only the general structure of this study, which helped determine the main deadlines and phases of this study. The phases of this study are presented in Figure 1.

Analysis methods

This study applied three types of analysis: descriptive analysis, content analysis, and co-citation analysis. A descriptive analysis aimed to present key information about selected studies, including authors' names, the year of publication, the journal name, listed keywords, and the research methodology that was implemented in each paper. Results of descriptive analysis provide the background and insights for further analysis (Mayring 2000).

Further, we implemented content analysis to summarise the findings and provide meaningful implications for future research. Content analysis is a replicable method of analysis that allows academics to analyse the content of the message (Nachmias and Nachmias 1976) and rigorous content analysis procedures allow the production of replicable results (Krippendorff, 1980). Content analysis was used to analyse definitions of empathy used in papers, and

keywords, as they demonstrate the context of the study. The WordItOut tool was used to analyse data. With this tool, we were able to analyse the frequency of usage of certain concepts and draw conclusions based on these insights. The datasets were analysed separately, and only words that were used two times or more were included.

The final step includes co-citation analysis which allows researchers to identify papers that are referenced together in the source publications (Hausberg and Korreck 2021). Co-citation analysis assumes that if papers refer to the same sources, it is more likely that their context, terminology, and approach to the phenomenon will be similar (Boyack and Klavans 2010; Hausberg and Korreck 2021). Therefore, each co-citation cluster extracted from the datasets helped us to understand what argumentation and perspectives dominate in empathy research within the entrepreneurial and engineering fields. The datasets were analysed using the VOSviewer software, which is a tool for mapping data based on bibliographical information (Van Eck and Waltman 2010). We conducted co-citation analysis for the cited authors with the minimum number of citations for each author set at 15.

Database and search terms

To answer the proposed research question, we searched the Scopus and Web of Science (WoS) databases. These databases were selected as they cover a wide range of peer-reviewed journals. Aiming to address the research question, we chose three keywords: 'entrepreneur', 'engineering', and 'empathy'. As empathy in both fields was in the focus of this study, it was decided to formulate two-word search strings as 'entrepreneur* AND empath*' and 'engineer* AND empath*'. This approach allowed the authors to identify publications with keywords present in the title, abstract, or listed keywords. The asterisk at the end of each keyword ensured the inclusion of words with different suffixes, such as 'empathy', 'empathic', 'engineering', 'entrepreneurial', and 'entrepreneurship'.

Criteria for source selection

The search was limited to articles with a focus on human-to-human empathy that contained a definition or conceptualisation of empathy within the field from peer-reviewed journals to ensure a high quality of extracted publications (conference papers, book chapters, reviews, books, and notes, among others, were not included). Only papers written in English were chosen for the study. Therefore, the inclusion criteria were papers written in English from peer-reviewed journals.

Papers on empathic design were not included because empathic design does not consider empathy as a separate phenomenon; this concept is a category

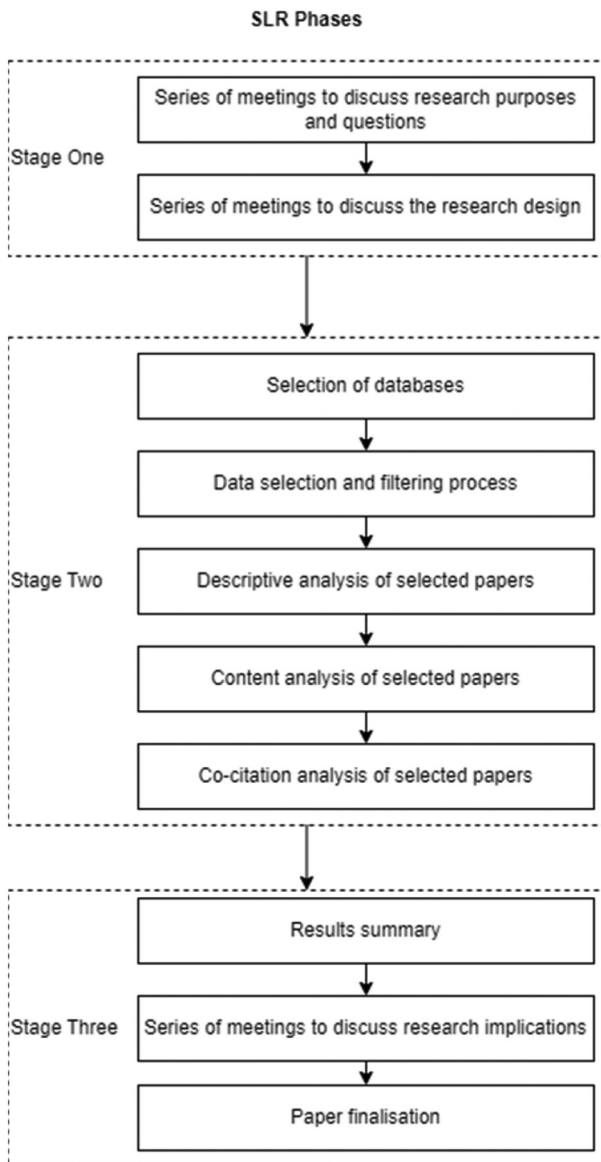


Figure 1. The phases of this systematic literature review.

of a human-centred design used independently as an entrepreneurial tool (Kouprie and Visser 2009; Zoltowski, Oakes, and Cardella 2012). Additionally, papers with limited focus on empathy (e.g. if the definition or conceptualisation of empathy was not provided in the paper) were excluded as they did not provide any contribution towards the understanding of empathy within the fields of engineering and entrepreneurship. Papers with a focus on empathy in human – computer interactions or robotic designs were also excluded because they are focused on interactions between humans and technological objects, which is out of the scope of this study.

Searching and filtering process

The data were retrieved from the Scopus database on 13 November 2021, and from the WoS database on

9 January 2022. In the preliminary search, 267 articles were retrieved from the Scopus database using the query string ‘engineer* AND empath*’ and 177 articles using the query string ‘entrepreneur* AND empath*’. The WoS database search identified 392 articles with ‘engineer* AND empath*’ requests, including 149 duplicates and 180 articles with ‘entrepreneur* AND empath*’ requests, including 96 duplicates. To conduct a descriptive analysis, two datasets were reviewed independently. The engineering literature dataset comprised conceptual and empirical papers in English focusing on empathy in engineering. The entrepreneurial literature dataset comprised conceptual and empirical papers in English with a focus on empathy in entrepreneurship; a total of 59 articles were retained after the title screening, and 18 articles were retained after screening papers by abstract and full text. After the title screening, 66 articles were retained in the dataset; 22 articles were retained once the abstracts and full papers were reviewed. The searching and filtering process is summarised in Table 1.

The complete list of publications was not included in this study because of space limitations. However, the list can be provided upon request. The selected papers from the field of engineering are presented in Table 2.

Selected papers from the field of entrepreneurship are presented in Table 3 that also demonstrates the diverse range of research approaches adopted in the papers from the entrepreneurial literature dataset.

Results

Results of the descriptive analysis

Figure 2 presents the number of papers related to empathy in engineering by year of publication. It can be noted that since 2012 there has been an increase in the number of publications on this topic.

We also highlighted the main contributors to academic research on the topic of empathy within the engineering context. As per Table 4, Justin Hess produced most of the relevant papers ($N = 10$). Nicholas Fila, Shari Miller, Nicola Sochacka, Johannes Strobel, and Joachim Walther published four papers each, Rui Pan and Senay Purzer published three papers each, while the others published a maximum of two articles.

Figure 3 presents the number of papers related to empathy in entrepreneurship by year of publication. Similar to the engineering field, the number of publications has increased since 2015. However, unlike in the engineering field, it is not possible to highlight authors who are the main contributors to the topic of empathy in entrepreneurship as each author produced only one paper.

From the descriptive analysis, it can be concluded that although there is growing interest in

Table 1. Data selection and filtering process.

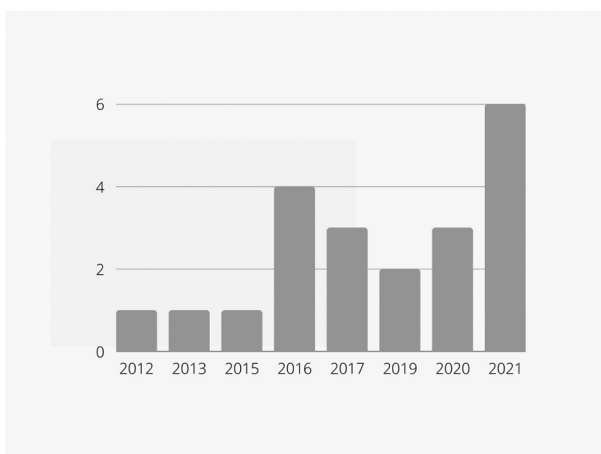
Database search		Preliminary search	articles after title reading	Articles remained after abstract & full paper skimming
SCOPUS search	TITLE-ABS-KEY (engineer* AND empath*) AND (LIMIT-TO (DOCTYPE,"ar"))	267 articles	66 articles	22 articles (the engineering literature dataset)
Web of Science search	engineer* AND empath* in title OR in abstract OR topic	392 articles (including 149 duplicates)		
SCOPUS search	TITLE-ABS-KEY (entrepreneur* AND empath*) AND (LIMIT-TO (DOCTYPE,"ar"))	177 articles	59 articles	18 articles (the entrepreneurial literature dataset)
Web of Science search	entrepreneur* AND empath* in title OR in abstract OR topic	180 articles (Including 96 duplicates)		

Table 2. Analysed papers: the engineering literature dataset.

Year of Publication	Authors	Title	Journal	Research approach
2012	Rasoal et al. (2012)	Empathy among students in engineering programmes	European journal of engineering education	Qualitative
2013	Strobel et al. (2013)	Empathy and care within engineering: Qualitative perspectives from engineering faculty and practicing engineers	Engineering Studies	Mixed
2015	Akgün et al. (2015)	Antecedents and consequences of collective empathy in software development project teams	Information & Management	Quantitative
2016	Hess and Fila (2016b)	The manifestation of empathy within design: findings from a service-learning course	CoDesign	Qualitative
2016	Hess et al. (2016a)	Voices from the workplace: practitioners' perspectives on the role of empathy and care within engineering	Engineering Studies	Qualitative
2016	Fila et al. (2016)	Engineering students' utilization of empathy during a non-immersive conceptual design task	The International journal of engineering education	Mixed
2016	Hess et al. (2016b)	The relationship between empathic and innovative tendencies among engineering students	The International journal of engineering education	Quantitative
2017	Hess et al. (2017)	Insights from industry: a quantitative analysis of engineers' perceptions of empathy and care within their practice	European Journal of Engineering Education	Quantitative
2017	Walther et al. (2017)	A model of empathy in engineering as a core skill, practice orientation, and professional way of being	Journal of Engineering Education	Conceptual paper
2017	Hess et al. (2017)	The development of empathic perspective-taking in an engineering ethics course	Journal of Engineering Education	Qualitative
2019	Haag and Marsden (2019)	Exploring personas as a method to foster empathy in student IT design teams	International Journal of Technology and Design Education	Qualitative
2019	Hess et al. (2019)	Enhancing engineering students' ethical reasoning: Situating reflexive principlism within the SIRA framework	Journal of Engineering Education	Quantitative
2020	Shah et al. (2020)	Inclusive Circles of Conversation: Implementing AN Innovative Diversity Program among Engineering Faculty and Staff	Journal of Women and Minorities in Science and Engineering	Qualitative
2020	Sochacka et al. (2020)	A qualitative study of how mental models impact engineering students' engagement with empathic communication exercises	Australasian Journal of Engineering Education	Qualitative
2020	Walther et al. (2020)	Empathy and engineering formation	Journal of Engineering Education	Qualitative
2020	Hess et al. (2021)	Empathy and ethical becoming in biomedical engineering education: a mixed methods study of an animal tissue harvesting laboratory	Australasian Journal of Engineering Education	Mixed method
2021	Hess et al. (2021)	Measuring Empathy for Users in Engineering Design	International Journal of Engineering Education	Quantitative
2021	Guanes et al. (2021)	Empathic approaches in engineering capstone design projects: student beliefs and reported behaviour	European Journal of Engineering Education	Qualitative
2021	Wallisch et al. (2021)	Fostering User-Empathy Skills of Engineering Students by Collaborative Teaching	International Journal of Engineering Education	Qualitative
2021	Huerta et al. (2021)	Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students	Journal of Engineering Education	Qualitative
2021	Sochacka et al. (2021)	Empathy Instruction through the Propagation Paradigm: A synthesis of developer and adopter accounts.	Advances in Engineering Education	Conceptual paper
2021	Alzayed et al. (2021)	Are you feeling me? An exploration of empathy development in engineering design education	Journal of Mechanical Design	Mixed

Table 3. Analysed papers: the entrepreneurial literature dataset.

Year of Publication	Authors	Title	Journal	Research approach
2015	McMullen (2015)	Entrepreneurial judgment as empathic accuracy: A sequential decision-making approach to entrepreneurial action	Journal of Institutional Economics	Conceptual
2016	Prandelli et al. (2016)	In user's shoes: An experimental design on the role of perspective taking in discovering entrepreneurial opportunities	Journal of Business Venturing	Quantitative
2017	Ip et al. (2017)	Revisiting the antecedents of social entrepreneurial intentions in Hong Kong	International Journal of Educational Psychology	Quantitative
2018	Bacq and Alt (2018)	Feeling capable and valued: A prosocial perspective on the link between empathy and social entrepreneurial intentions	Journal of Business Venturing	Quantitative
2018	Khalid and Sekiguchi (2018)	The role of empathy in entrepreneurial opportunity recognition: An experimental study in Japan and Pakistan	Journal of Business Venturing Insights	Quantitative
2019	Ashraf (2019)	Determinants of Islamic entrepreneurial intentions: an analysis using SEM	Journal of Islamic Marketing	Quantitative
2019	Urban, and Galawe (2019)	The mediating effect of self-efficacy on the relationship between moral judgement, empathy, and social opportunity recognition in South Africa	International Journal of Entrepreneurial Behavior & Research	Quantitative
2019	Zakaria et al. (2019)	The determination of social entrepreneurial intention: a mediated mediation analysis	Academy of Entrepreneurship Journal	Quantitative
2019	Yu et al. (2019)	Factors affecting social entrepreneurship intentions among agricultural university students in Taiwan	International Food and Agribusiness Management Review	Quantitative
2020	Le et al. (2020)	When giving is good for encouraging social entrepreneurship	Australasian Marketing Journal (AMJ)	Quantitative
2020	Mohammadi et al. (2020)	Do Islamic Values Impact Social Entrepreneurial Intention of University Students in Malaysia? An Empirical Investigation into The Mediating Role of Empathy	International Journal of Economics & Management	Quantitative
2020	Lambrechts et al. (2020)	Unravelling the Role of Empathy and Critical Life Events as Triggers for Social Entrepreneurship	Frontiers in Psychology	Qualitative
2020	Zhao et al. (2020)	Influence Mechanism of Dynamic Evolution of Chinese Entrepreneurs' Entrepreneurial Motivation on Performance—The Role of Turning Points and Empathy	Frontiers in Psychology	Qualitative
2021	Usman et al. (2021)	Impact of empathy, perceived social impact, social worth, and social network on the social entrepreneurial intention in socio-economic projects	Journal of Entrepreneurship in Emerging Economies.	Quantitative
2021	Packard and Burnham (2021)	Do we understand each other? Toward a simulated empathy theory for entrepreneurship	Journal of Business Venturing	Conceptual
2021	Younis et al. (2021)	Impact of positivity and empathy on social entrepreneurial intention: The moderating role of perceived social support	Journal of Public Affairs	Quantitative
2021	Tan et al. (2021)	Personality traits and social entrepreneurial intention: the mediating effect of perceived desirability and perceived feasibility	The Journal of Entrepreneurship	Quantitative
2021	Keles, Taysir, and Asarkaya (2021)	Personal Antecedents of Social Entrepreneurial Intention in Different Country Clusters and Fields	VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations	Qualitative


Figure 2. Number of papers about empathy in engineering by year of publication.

empathy research in both fields, academics choose different approaches to explore it. Within the entrepreneurial field, most papers implemented

the quantitative approach aiming to identify the relationship between empathy and various aspects of entrepreneurial activity (primarily, entrepreneurial intentions). However, researchers from the field of engineering explore the phenomenon of empathy itself and strategies to develop it.

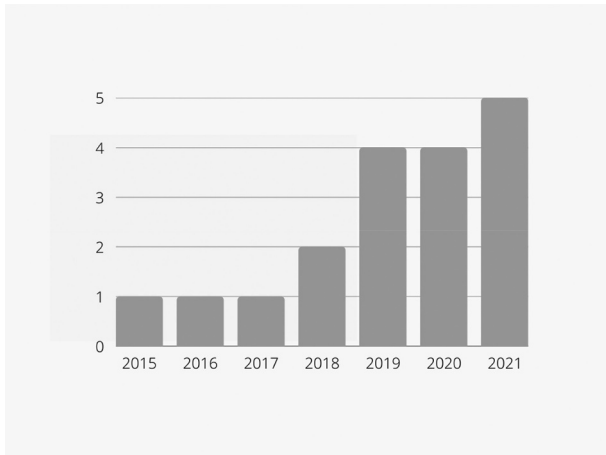
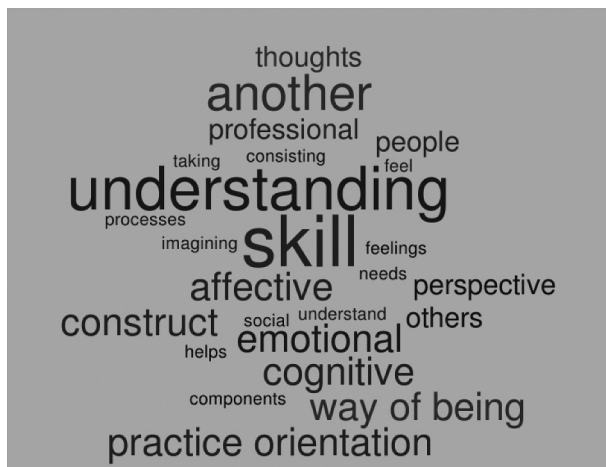
Results of the content analysis (engineering literature)

The purpose of content analysis was to understand how authors conceptualise empathy, focusing on definitions and keywords. We extracted definitions and keywords from each paper and analysed them using the word cloud tool. Therefore, we were able to count the frequency of word usage and draw conclusions based on these results. The words that were used at least twice are presented in Figure 4.

The three overarching themes related to existing understandings and definitions of a phenomenon of

Table 4. Number of papers published by each author.

Author	Number of papers by author
Hess J. L.	10 papers
Fila N. D., Miller, S. E., Sochacka, N. W., Strobel, J., Walther, J., Pan, R., Purzer, S.	4 papers
Brightman, A. O., Delaine, D. A., Dringenberg, E., Wachter Morris, C. A.	3 papers
Akgün, A. E., Alzayed, M. A., Beever, J., Brewer, M. A., Briede-Westermeyer, J. C., Carberry, A. R., Cebecioglu, A. Y., Danielsson, H., Dogan, D., Elison, Z., Fore, G. A., Guanés, G., Haag, M., Higbee, S., Huerta, M. V., Huff, J., Jungert, T., Keskin, H., Kim E., Kisselburgh, L., Kokini, K., Luzardo-Briceno, M., Marsden, N., McKenna, A. F., McComb, C., Menold, J., Miller, S. R., Pipe, T., Rasool, C., Shah, C., Shepard, T. G., Wallace, J., Wallisch, A., Wang, L., Youngblood, K. M., Zoltowski, C. B.	2 papers
	1 paper

**Figure 3.** Number of papers about empathy in entrepreneurship by year of publication.**Figure 4.** Words commonly used in defining empathy in engineering literature.

empathy emerged within the word cloud results: *empathy focus* (what empathy is aimed at), *empathy as* (how empathy is conceptualised), and *empathy characteristics* (different states/dimensions/facets attributed to empathy) (Table 5).

Empathy focus

Firstly, chosen engineering studies conceptualise and define empathy as an other-oriented process focusing on ‘another’, ‘others’, or ‘people’. It also should be

noted that in engineering literature, some researchers highlight the equally important role of self-oriented facets of empathy (e.g. Hess and Fila (2016a) conceptualise empathy as a four-part phenomenon that varies between affect/cognition and self/other orientation). However, the results of content analysis demonstrate that definitions, where self-oriented components are equally important as other-oriented ones, do not prevail in engineering discourse. Secondly, unlike the literature from the entrepreneurial field (where many definitions outline the focus of empathy on feelings and emotions), the engineering literature focuses on perspectives and thoughts (e.g. empathy can be described as cognitive, as understanding another’s thoughts and perspectives (Eslinger 1998)). These focuses relate mostly to cognitive components of empathy such as perspective-taking or imagining.

Empathy as

Along with the entrepreneurial literature, papers from the engineering field also have a common conceptualisation of empathy as ‘understanding’. However, in contrast to the entrepreneurial publications that understand empathy as an ability, engineering studies rely on the understanding of empathy as a skill that is learnable or can be developed (Walther et al. 2020; Hess et al. 2021). This definition is due to the model of empathy developed by Walther et al. (2020) which conceptualises empathy as a skill, a practice-orientation, and a professional way of being. Also, it is important to mention that some publications use definitions that conceptualise empathy as a construct that involves cognitive and affective components, emphasising the multi-faceted nature and complexity of this phenomenon (e.g. empathy is a multifaceted construct that involves both cognitive and affective components (Tenenberg, Socha, and Roth 2014)).

Empathy characteristics

Engineering literature, as well as entrepreneurial academic publications, highlight the cognitive, affective, and emotional characteristics of empathy. At the same time, an important component of empathy in engineering is a professional characteristic. This characteristic highlights the importance of empathy in the professional career of an engineer and also

Table 5. Understandings of empathy in entrepreneurial literature (themes emerged from definitions).

Themes	Codes
Empathy focus	Another (N=5) Thoughts (N=3) Perspective (3) People (3) Others (3)
Empathy as	Skill (N=7) Understanding (N=6) Way of being (N=4) Practice-orientation (N=4) Construct (N=4)
Empathy characteristics	Emotional (N=4) Affective (N=4) Cognitive (N=4) Professional (N=3)

demonstrates the importance of context when creating conceptual models of empathy and educational approaches aimed at developing this characteristic of empathy.

Keywords content analysis

The results of the content analysis of keywords from the papers related to empathy within the engineering fields are presented in Figure 5. The words and collocations extracted during the content analysis reflect the trend in empathy research within the engineering field. Firstly, empathy is considered one of the ‘professional skills’ ($N=4$) that modern engineers should possess, and as an important element of ‘engineering practice’ ($N=2$). Secondly, the presence of the collocations ‘engineering education’ ($N=4$) and ‘student development’ ($N=2$) reflects that contemporary research is currently exploring approaches and methods focused on the development of empathy in the engineering context. At the same time, in engineering education literature the prevailing understanding is that empathy is a learnable and teachable skill (Walther et al. 2020; Hess et al. 2021). Also, it is important to mention that engineering literature conceptualises empathy as

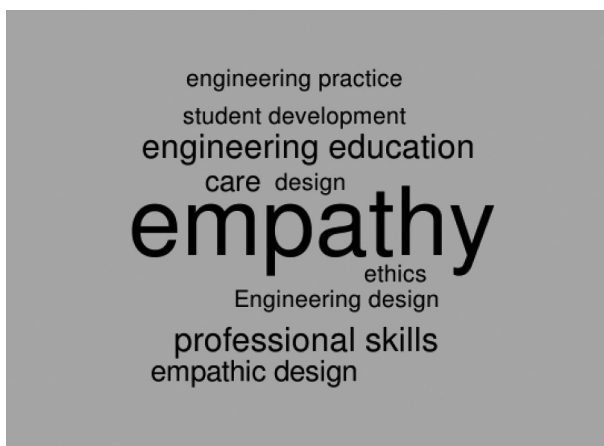


Figure 5. Common keywords from the engineering literature dataset.

an important component in the design process as three frequent keywords relate to this topic: ‘empathic design’ ($N=3$), ‘engineering design’ ($N=2$) and ‘design’ ($N=2$). It is also important to highlight that different studies emphasise the connection (relationship) with some moral concepts like ‘ethics’ and ‘care’. For example, Hess et al. (2019, 83) state that ‘empathy is a core component of ethical reasoning’. In regard to empathy and care, it is worth mentioning that these concepts are explored together by groups of researchers as an integral part of professional practice that allows engineers to address challenges of modern practice (Strobel et al. 2013; Hess et al. 2016b; Hess, Strobel, and Brightman 2017).

Results of the content analysis entrepreneurial literature

Similar to the content analysis of the dataset with engineering literature, the definitions of empathy within the entrepreneurial field were analysed with the WordItOut tool and those that were used at least twice are presented in Figure 6.

Through content analysis, three overarching themes related to existing understandings and definitions of a phenomenon of empathy emerged within the word cloud results: *empathy focus* (what empathy is aimed at), *empathy as* (how empathy is conceptualised), and *empathy characteristics* (different states/dimensions/facets attributed to empathy) (Table 6).

Empathy focus

Firstly, after the analysis of the definitions of empathy in the entrepreneurial literature, it can be noted that empathy is mostly interpreted as an other-oriented phenomenon because the words ‘other’ and ‘another’ are commonly used in the definitions of empathy. Secondly, the words most often used in definitions are ‘emotions’ and ‘feelings’ as a focus of empathy. A widely used definition is the one suggested by Mair and Noboa (2006), which states that empathy is the ability to perceive and share others’ emotions. This understanding focuses on affective characteristics. Due to the more frequent mention of these words as a focus of empathy, it can be stated that the understanding of empathy as a phenomenon related to (focused on) emotions (sharing and perception of emotions) or feelings prevails in entrepreneurial literature.

Empathy as

The results of the analysis demonstrate that the most commonly used words in definitions of empathy that conceptualise this phenomenon are ‘ability’, ‘understanding’, or ‘understand’. For example, these words

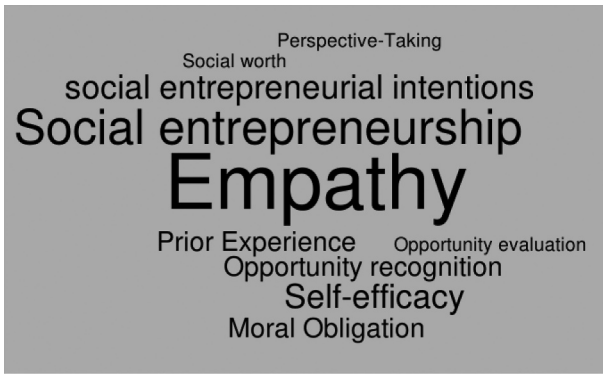


Figure 7. Common keywords from the entrepreneurial literature dataset.

to other entrepreneurial concepts such as ‘social worth’ ($N=2$), ‘moral obligation’ ($N=3$), ‘self-efficacy’ ($N=4$), ‘perspective-taking’ ($N=2$) or ‘prior experience’ ($N=3$). A range of papers (mostly quantitative) is aimed at exploring and measuring connections between empathy and various aspects of entrepreneurial mindset, and ‘social entrepreneurial intentions’ ($N=4$) are the most common focus of research interest. In addition to research on the relationship between empathy and entrepreneurial concepts, the entrepreneurial literature explores the role of empathy in particular entrepreneurial processes, such as ‘opportunity recognition’ ($N=3$), and ‘opportunity evaluation’ ($N=2$). In this regard, it can be concluded that, unlike engineering literature, where most of the studies are aimed at exploring the role of educational activities (contexts) in the development of empathy or the formation of empathy models for engineering education that take into account the contextual features of engineering practice, entrepreneurial literature is mainly aimed at studying the role and connections of empathy with specific entrepreneurial processes (e.g. opportunity recognition) and concepts (self-efficacy or entrepreneurial intentions). At the same time, most entrepreneurial studies investigate empathy not in educational but in practical contexts.

Results of the co-citation analysis

As this study aimed to review how academic publications conceptualise and define empathy in entrepreneurship and engineering fields, it was essential to identify the primary concepts and the authors cited in the selected papers for both the datasets. Thus, we were able to compare the results of the co-citation analysis with the results of the content analysis and validate the outcomes. Secondly, as we understood primary sources in these papers, it became possible to describe a more complete picture of the understanding of empathy and connect this understanding with the theoretical knowledge.

As a result of the co-citation analysis, the engineering literature dataset was divided into three clusters with Fila N., Hess J., Pan R., Strobel J., and Davis M. in Cluster 4; Miller S., Sochacka N., and Walther J. in Cluster 5; and Brightman A., Oakes W., and Zoltowski K. in Cluster 6 (Figure 8).

The most common references from the entrepreneurial literature dataset were also combined into three clusters (Figure 9). Cluster 1 includes Davis M., McMullen J., and Shepherd D.; Cluster 2 includes Bandura A., Caprara G., and Khan A.; and Cluster 3 includes Hockerts K., Mair J., Grant A., Sarstedt M., and Linan F.

In the engineering field, papers are mostly based on research that focuses on empathy and engineering education and attempts to provide theoretical modeling of empathy (Cluster 1, Cluster 2). In addition, they rely on sources exploring connections between empathy and engineering ethics and design processes (Cluster 3). In the entrepreneurial field, analysed papers refer to publications that investigate empathy in relation to various entrepreneurial concepts such as entrepreneurial mindset (Cluster 4), self-efficacy (Cluster 5) or entrepreneurial intentions (Cluster 6). The clusters are described in Table 7.

Summary of results

Existing research of empathy in entrepreneurship is primarily aimed at investigating the links or causality between empathic abilities and specific phenomena, such as entrepreneurial intentions or opportunity recognition, using quantitative methods, while many researchers in the field of engineering study the role of educational contexts in developing empathy or affecting the meaning making process of this phenomenon. That is why the many engineering researchers conceptualise empathy as an ability or skill as well as an essential element of engineering practice. Compared with the entrepreneurial literature, empathy engineering researchers are focused on creating a holistic understanding of this phenomenon, taking into account the contextual features of engineering practice, to create different educational interventions aimed at developing empathy in future engineers.

Discussion

The results of this literature review demonstrated that engineering and entrepreneurial research are moving along their own development trajectories with different goals and understandings of the phenomenon of empathy. In entrepreneurship, there were no intentions to consider the questions (topics) of the importance of empathy or what the process of empathy is (how entrepreneurs empathise). Rather, the research trend was aimed at understanding what role empathy

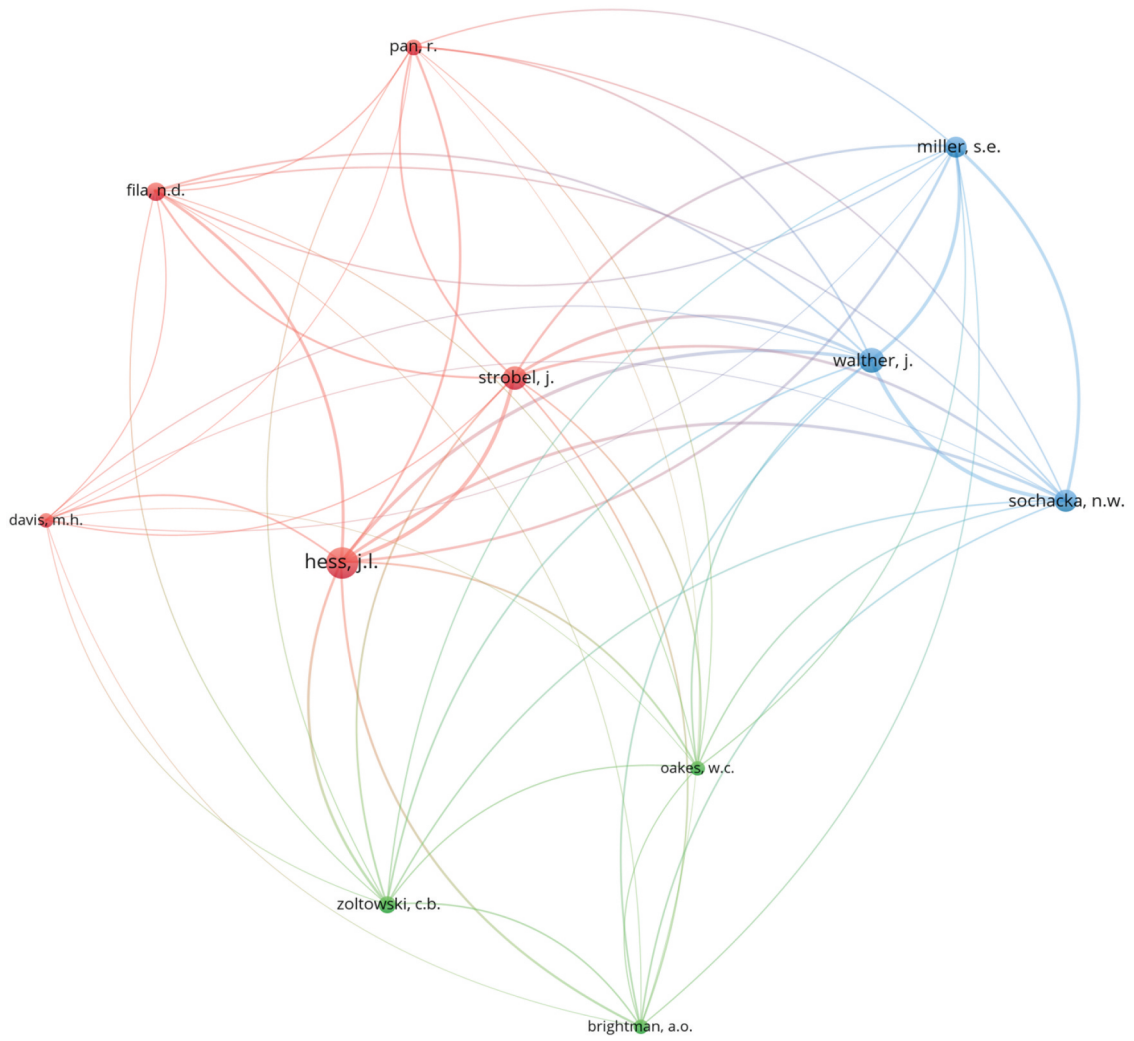


Figure 8. Co-citation analysis of the papers on empathy in engineering.

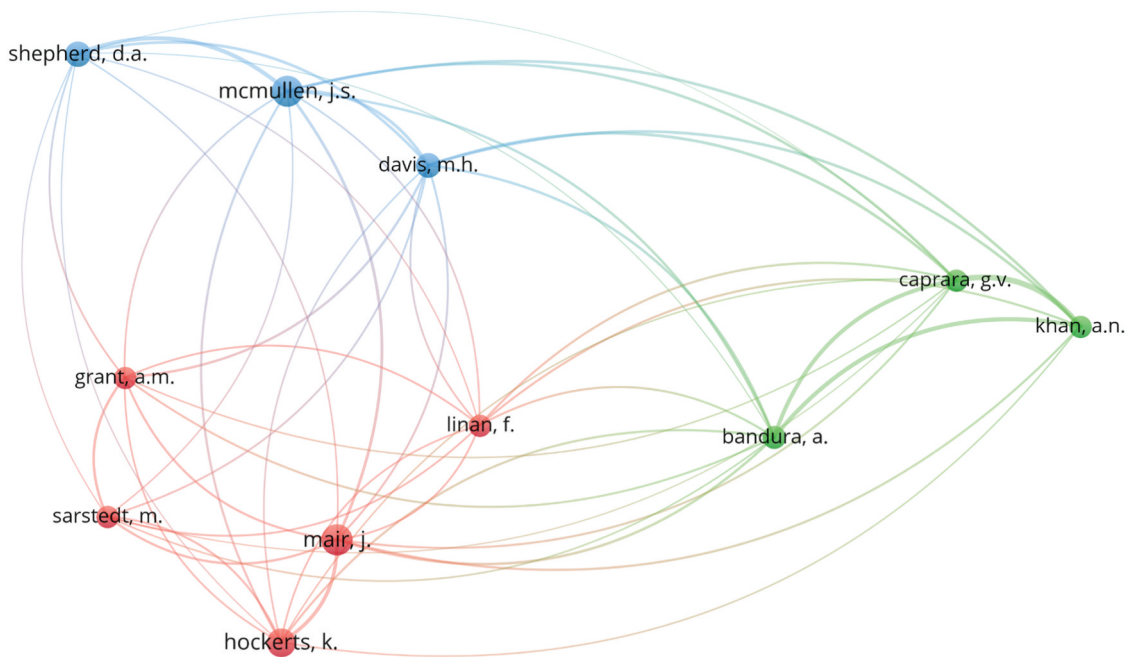


Figure 9. Co-citation analysis of the papers on empathy in entrepreneurship.

Table 7. Research focus of authors in identified clusters.

Empathy in engineering		Empathy in entrepreneurship	
Cluster 1 (Fila N., Hess J., Pan R., Strobel J., and Davis M.)	Empathy and engineering education	Cluster 4 (Davis M., McMullen J., and Shepherd D.)	Empathy/empathic accuracy; entrepreneurial cognition and mindset/entrepreneurial process
Cluster 2 (Miller S., Sochacka N., and Walther J.)	Empathy and engineering education (using the model of empathy as skill, practice-orientation, and way of being)	Cluster 5 (Bandura A., Caprara G., and Khan A.)	Empathy/self-regulatory mechanisms and self-efficacy
Cluster 3 (Brightman A., Oakes W., and Zoltowski K.)	Empathy/ethics/design	Cluster 6 (Hockerts K., Mair J., Grant A., Sarstedt M., and Linan F.)	Empathy/entrepreneurial intentions/ social entrepreneurship

plays in particular entrepreneurial processes, as well as exploring the connection of empathy with specific entrepreneurial concepts, such as entrepreneurial intentions. Korte, Smith, and Li (2018) stated that, due to the fact that any small business or start-up can be considered a social enterprise, it is essential for founders to have the ability to sense and communicate with others in order to succeed. At the same time, according to Packard and Burnham (2021, 2), entrepreneurship “is primarily a process of solving others’ problems” and that by using empathy (or its components) ‘entrepreneurs propose and provide novel solutions to other people’s problems’ (Chiles et al. 2010, 20). In this regard, in these contexts’ empathy is considered as a priori being in the context (in that the understanding of empathy as an ability has become widespread) and it is only necessary to understand in the processes in which empathy plays a greater or lesser role. This situation has led to the application of a large number of different definitions and models of empathy in entrepreneurial research (since there was no goal to develop entrepreneurial contextual models of empathy). So far, entrepreneurship conceptualisation and theorisation on the phenomenon of empathy has been characterised by the fragmented state of research, which has offered ‘nearly as many definitions of empathy as there are scientists who study this phenomenon’ (Zaki, 2014, p. 1608; Packard and Burnham 2021). At the same time, Packard and Burnham (2021, 2) stated, ‘We need an accepted theory of empathy. While there are several extant theories of empathy, each define “empathy” differently, and none meet the requirements of modern entrepreneurship theory’. In this regard, despite single attempts to theorise empathy within the field of entrepreneurship (e.g. Packard and Burnham 2021), most studies aim to determine the relationship of empathy with certain processes or prerequisites for entrepreneurship based on a large number of different understandings of this phenomenon.

Traditionally, engineers have a lower degree of empathy (Rasoal, Danielsson, and Jungert 2012). Cech (2014) explored that modern engineering educational approaches do not contribute to the formation of empathy and that students’ interest in public

welfare had a tendency to decline during a typical engineering course. Therefore, the analysed research studies were focused more on how to develop empathy (reflecting that in engineering there is a common understanding of empathy as a skill) and what it is (since to teach empathy effectively it is essential to understand the nature and process of this phenomenon). This direction has led to the trend of creating different contextual and holistic models of empathy in engineering that can be used to propose specific educational interventions focused on developing this phenomenon in engineering students taking into account specific attributes of the engineering practice. For example, Hess and Fila (2016b) considered the self and the other as well as the affective and cognitive dichotomies, proposed a taxonomy of distinct empathy types such as emotional congruence, empathic concern, perspective-taking, and projection. Walther, Miller, and Sochacka (2017), relying on the work of authors from the fields of psychology (e.g. Decety and Moriguchi 2007), social work (Gerdes and Segal 2009; Segal 2011), engineering ethics (Fleddermann, 2012; Jonassen et al. 2009; Hashemian and Loui 2010; Whitbeck 2011), and human-centred design (Zoltowski, Oakes, and Cardella 2012), proposed a model of empathy in engineering by conceptualising this phenomenon as a core skill, practice orientation, and way of being. In this regard, it can be noted that at present, the study of empathy in engineering and entrepreneurship follow different trajectories (and therefore form different types of knowledge), which in turn are guided by problems and challenges, as well as by the peculiarities of engineering and entrepreneurial practice.

Implications to entrepreneurial engineering research

According to Korte, Smith, and Li (2018), to prepare future empathic engineers with a developed entrepreneurial mindset, it is essential to teach (develop) empathy, not only by integrating into engineering curriculum entrepreneurial educational activities, but also through paying attention to the process of developing a holistic engineer. Therefore, in order to

develop a model of empathy in entrepreneurial engineering that can be a foundation for teaching this phenomenon, it is important to take into account existing knowledge and research. Firstly, empathy should become more visible in programs aimed at preparing future entrepreneurial engineers. The review results demonstrate that educational approaches that emerged in the engineering literature highlight empathy as an important component for professional formation, some even considering it a core skill in engineering education and practice (Walther et al. 2020). However, in the entrepreneurial literature, empathy is not visible enough and is mostly seen as a small part (component) of other processes or practices. Therefore, the need to develop models of empathy begins to form, aiming to holistically understand the phenomenon of empathy within entrepreneurial practice. Packard and Burnham (2021) declare that it is important to disrupt existing research approaches to empathy and ‘reignite’ empathy theorising as there are many potential implications of empathy in entrepreneurship that should be investigated to make empathy more visible. That is why, to teach empathy in entrepreneurial engineering, it is important to have a model that also conceptualises empathy as a core skill in entrepreneurship. In this regard, it is important not only to investigate in detail and understand what the empathy process is in entrepreneurship but also to support the aspirations of educators in their attempts to make empathy more viable in their teaching practices.

Secondly, when creating models of empathy and considering teaching and development approaches in entrepreneurial engineering, it is important to take into account not only contextual features and adhere to a holistic approach, but also the existing dichotomies inherent to the phenomenon of empathy, such as self/other, skills/ability etc. Moreover, the empathy model for entrepreneurial engineers should consider cognitive and affective components as they play an important role in empathy processes (Walther et al. 2020). Batson, Early, and Salvarani (1997) add that when empathising, it is important not only to imagine how other people feel or think but to imagine how one would feel and think in other situations. Researchers and educators should also take into account that empathy can be developed, and also that some people have higher empathic abilities than others. In addition, this review demonstrates that in some studies, the authors focus on only one part of the dichotomy (for example, either emotions or thoughts). However, to create a model of empathy in entrepreneurial engineering as well as effective teaching methods, it is important to consider

both parts to demonstrate all the facets of this phenomenon and emphasise its importance in practice.

In conclusion, the future models of empathy and teaching approaches in entrepreneurial engineering should take into account the contextual features of both fields (engineering and entrepreneurship), reflect the existing dichotomies that are part of the empathy process, and also conceptualise empathy as a core concept that plays an essential role in both engineering and entrepreneurship fields and practices.

Research limitations and recommendations for future research

The main aim of this systematic literature review was to uncover how empathy is understood and conceptualised in modern entrepreneurial and engineering academic literature to create a foundation for the future development of contextual and theoretical models of empathy in entrepreneurial engineering. The main limitation is that this study examined only two main fields: entrepreneurship and engineering literature related to empathy. However, in order to understand the role of empathy in entrepreneurship and engineering, it is also important to investigate other related disciplines or processes that are part of engineering and entrepreneurial practice. Future research should focus on exploring the role of empathy in other related domains, such as marketing or design, and consider the models, instruments, and methodologies where it acts as an essential component (e.g. design thinking and user experience research).

Secondly, this review has identified a direction of empathy research in entrepreneurship as part of a broader process. At the same time, in order to create conceptual and educational models, it is also important to understand the nature of the phenomenon and the stages (phases) that are involved in it. Future research may focus on the lived experiences of engineering entrepreneurs to understand how they experience empathy and the practices that empathy is part of.

It would also be beneficial to expand the scope of the review and include more databases and languages. This research included papers written in English only, and it is notable that during the filtering stage a number of articles in Korean were excluded due to the authors’ inability to read them. Also, the search was conducted on Scopus and Web of Science databases, and it could be expanded to get a more complete picture of the research in the field.

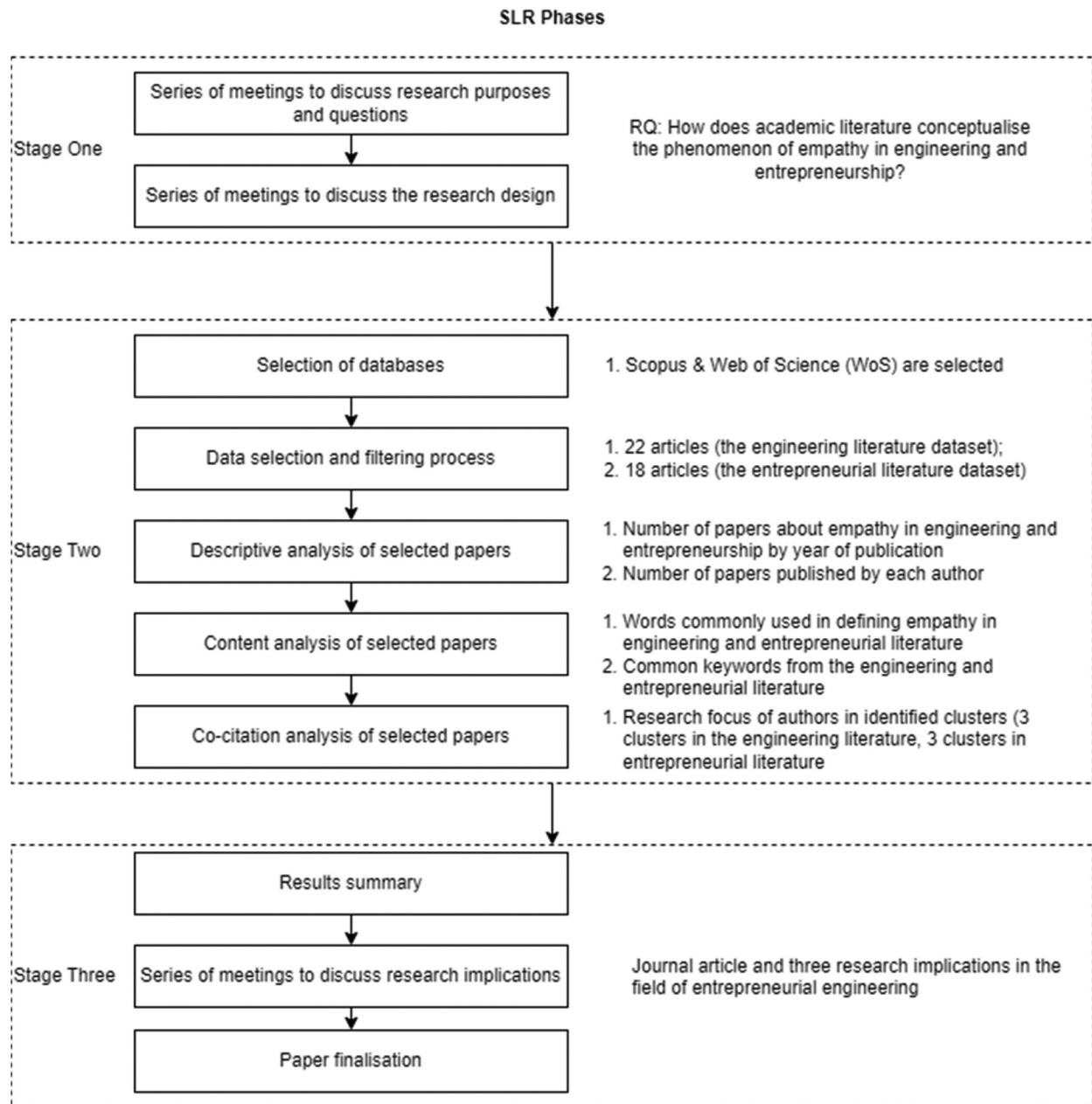


Figure 10. Research process and outcomes of each phase.

The summary of the research process with research outcomes is presented in Figure 10.

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