

Article

Identifying Key Assessment Factors for Human Capital Agility and Leadership Agility

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Abstract: In the era of VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) and technological disruption, Indonesia's construction sector faces significant challenges. This study aims to identify and evaluate the key components of human capital agility, leadership agility, and project success within this sector. Using a combination of systematic literature reviews, Focus Group Discussions (FGD), and the Fuzzy Delphi Method (FDM), this research develops and refines assessment frameworks for these variables. The findings highlight that project success extends beyond the traditional dimensions of time, cost, and quality (iron triangle) to include sustainability, environmental performance, and stakeholder satisfaction. From 20 proposed components, 17 were validated for human capital agility, emphasizing flexibility, responsiveness, and proactivity as key elements. Similarly, leadership agility is characterized by resilience, emotionally intelligent, adaptable, and responsive, with 17 validated components out of 22. Furthermore, this study identifies critical project success factors, including time, quality, profitability, health, cost and safety, with defuzzification scores exceeding 0.89. This research contributes both theoretically and practically by providing a strategic framework to enhance the competitiveness and sustainability of Indonesia's construction sector. Stakeholders are encouraged to optimize human capital and leadership agility to effectively address dynamic project environments.

Keywords: human capital agility; leadership agility; project success; construction sector; sustainability



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1. Introduction

Indonesia's construction sector has experienced significant growth in recent years, driven by the increasing need for national infrastructure [1]. The sector plays an important role as a pillar of economic growth and supports sustainable development. In addition to meeting the needs of physical infrastructure, the construction sector also contributes to creating jobs, improving connectivity, and driving local economic growth, especially in previously underdeveloped areas.

However, the rapid development of this sector is accompanied by significant challenges, especially in facing VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) conditions. This term describes an environment full of uncertainty, complexity, and ambiguity that directly impacts project planning and management processes [2]. The Focus Group Discussion (FGD) revealed that industry practitioners widely recognize the impact

of VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) conditions and technological disruption on Indonesia's construction sector. Participants emphasized increasing uncertainty and rapid changes, with IP4 and IP6 affirming that these challenges are significantly affecting project execution. IP6 further noted that uncertainty has complicated the proper implementation of construction management, while IP3 and IP7 highlighted the sector's volatility and dependence on government policies. However, despite the disruptive environment, technological advancements and automation have not significantly transformed the industry, as pointed out by IP6, who stated that Indonesia's construction sector has yet to embrace major technological shifts. Meanwhile, IP1 offered a contrasting view, arguing that uncertainty is driven internally rather than externally.

In response to this, generational diversity plays a crucial role, as it drives rapid changes in the way companies think, ultimately influencing Gen Z's leadership style and core competencies in dealing with the VUCA environment [3]. To navigate such conditions, companies must optimize their cognitive capacity to generate innovation quickly and ensure adaptability and resilience in an ever-changing landscape [4]. Furthermore, the success of organizational leadership in the VUCA era is influenced by several key factors, such as strategic vision, decision-making ability, understanding of information, situational awareness, decisiveness in acting, and responsiveness to change [5]. In this regard, leadership agility has emerged as a vital approach, enabling organizations to respond swiftly to challenges and opportunities through cycles of adaptation, continuous learning, and continuous improvement [6]. In addition, this era of disruption, marked by technological change, automation, and socioeconomic dynamics, further complicates the management of construction projects. The combination of VUCA and disruption has caused many projects to experience cost overruns of up to 87.94% and time delays of up to 156.59% from the initial schedule, as seen in the toll road project in Indonesia [7].

In addition to cost overruns and time delays, project success is often hampered by a lack of effective coordination between stakeholders, such as owners, consultants, and contractors. Poor coordination results in unplanned design changes that disrupt the overall project schedule and create greater uncertainty [8,9]. In addition, the availability of skilled labor is an obstacle to the implementation of construction projects in Indonesia. The lack of labor with special skills reduces the productivity and efficiency of the project, which ultimately affects the cost and time of project completion [10]. The Focus Group Discussion (FGD) highlighted several significant impacts of uncertainty and rapid changes on construction projects in Indonesia. One of the most pressing issues is the decline in project quality, as noted by IP6, who noted that within a year, contractors often blame deteriorating outcomes. Additionally, time and cost overruns were emphasized by IP3, who pointed out that uncertainty leads to delays and increased expenses. IP2 further elaborated that these challenges not only affect financial and quality aspects and extend to Health, Safety, and Environment (HSE) standards, as additional resources are required to mitigate risks. These findings suggest that the VUCA environment in the construction sector intensifies inefficiencies, making it crucial for industry players to develop adaptive strategies.

To face this challenge, an innovative approach is needed that includes leadership and human capital aspects in construction projects. Leadership is a fundamental part of organizational theory and has been widely studied in various disciplines [11]. Leadership is an important aspect of organizational success [12]. Competing in today's volatile and complex business environment (VUCA) requires organizational agility [13]. Having agile skills is useful for dealing with rapid changes, maintaining sustainability, and capturing new opportunities [14]. The three levers to increase organizational agility are strategic, operational, and leadership agility [13]. Leadership agility becomes an important aspect

when facing challenges in the VUCA and disruption eras. Leadership agility refers to a leader's ability to respond quickly and effectively, especially in uncertain situations.

In addition to leadership, project success is also influenced by human capital. Human capital is the individual potential of members of the organization in the form of physical, mental, intellectual, and moral qualities consisting of tendencies, skills, knowledge, skills, motivation, health, and essential energy resources that emphasize individual function and development [15]. In line with the challenges and developments of agile leadership needed in facing VUCA and the era of disruption, research related to human capital is starting to enter the discussion of human capital agility.

Human capital agility also plays a vital role in the success of construction projects. This concept refers to an organization's ability to manage talent and adapt workforce skills to evolving project requirements [16]. The ability to manage and develop these talents is an important element that holistically supports the achievement of project success, including technical, managerial, and strategic aspects. The Focus Group Discussion (FGD) revealed various strategies employed by construction companies to overcome obstacles and failures in achieving project targets. One key approach is mitigating volatility, as highlighted by IP1, highlighting the need to stabilize operations despite uncertainty. IP3 stressed the importance of implementing risk mitigation measures to safeguard project execution. Another critical strategy is placing competent and resilient leaders in key project roles, as noted by IP2, IP5, and IP6, who emphasized selecting experienced project managers with strong stress management skills.

Beyond leadership, strategic project selection plays a crucial role in minimizing risks. IP7 explained that companies should carefully assess projects before committing them by evaluating project owners and ensuring alignment with organizational capabilities. Additionally, optimizing work allocation and improving project management processes, such as material, labor, and equipment management, further enhance efficiency. IP7 also noted that refining work methods and delegating tasks to skilled teams can reduce potential losses and improve project outcomes.

Despite the complexity of challenges facing the construction sector, it is important to redefine the variables of project success. Thus far, project success has often been measured based on only three main criteria: quality, cost, and time [1,17]. The success of today's construction projects depends not only on timely and budgetary completion, but also on long-term impacts, such as environmental sustainability and other important components. Therefore, to address the challenges of the VUCA and the disruption era, it is important to define and determine more holistic components for assessing the success of construction projects.

Building upon the identified challenges, this study aims to determine and refine the key components that constitute human capital agility, leadership agility, and project success in Indonesia's construction sector, utilizing the Fuzzy Delphi Method (FDM). Accordingly, the research question developed in this study is as follows: "What are the key components of human capital agility, leadership agility, and project success that contribute to the success of construction projects in Indonesia"?

Results: This research is expected to provide new insights into the interaction between human capital agility, leadership agility, and construction project success. This understanding provides practical recommendations for stakeholders in developing more effective policies to improve the competitiveness, efficiency and sustainability of the construction sector. In the long term, this research is expected to strengthen the reputation of the Indonesian construction sector in the eyes of investors and the public through an innovative approach that holistically supports project success.

2. Theoretical Background

A theoretical review of Human capital agility, Leadership agility, Project management, and Project success in the Indonesian construction sector.

2.1. Project Management

During increasingly tight competition, businesses and organizations must be more efficient and effective in project execution [18]. With limited resources, project managers must focus on the most important factors to ensure project success [19]. The role of project management is becoming increasingly important for project success [18]. Several recent studies related to project success factors (Critical Success Factors) in the implementation of project management can be grouped into five main categories, namely, project-related factors, consultant-related factors, work environment-related factors, human capital-, and leadership-related factors. Each of these factors includes various sub-factors that collectively contribute to the effectiveness of project implementation. Additional details on the critical success factors in project management implementation are provided in Table 1, which presents the critical success factors in project management implementation.

Table 1. Critical success factors in implementation of project management.

Critical Success Factors	A	B	C	D	E	F	G	H	I	J	K	L	M	N
I. Project-related factors														
Clear project goals		v	v		v						v			
Adequacy of project funds		v	v				v		v		v			
Project planning											v			
Project monitoring and controlling					v	v						v		
Risk management and mitigation												v		v
Effective procurement management												v		
Adaptability to changing requirements														v
Managing complex projects														v
Efficient resource utilization														v
Realistic project schedule									v					
II. Consultant-related factors														
Project consultant competency		v	v											
Prior experience of consultant			v											
Consultant willingness and cooperation			v											
III. Work-environment-related factors														
Effective communication	v				v	v		v	v			v	v	
Internal and cross collaboration	v				v			v						v
Commitment of all participants								v						
Enhanced stakeholder engagement												v		v
Transparency														v
Coordination													v	
Know-how and power sharing	v								v					

Table 1. Cont.

Critical Success Factors	A	B	C	D	E	F	G	H	I	J	K	L	M	N
IV. Human-capital-related factors														
The team's technical capacity				v										
The team's soft skills				v				v						
Teamwork efficiency	v													
Core-self evaluation										v				
Competent project team												v		
Team experience									v					
V. Leadership-related factors														
Top management support				v	v	v	v	v	v		v	v		
Sustainable project leadership										v				
Empowerment										v				v
Project manager leadership skills											v			
Project manager capabilities and commitment												v		

Note: A: (Nunes and Abreu, 2020) [20]; B: (Belay et al., 2021) [21]; C: (Belay et al., 2022) [22]; D: (Correia and Martens, 2022) [23]; E: (Wang et al., 2023) [24]; F: (Mashali et al., 2023) [25]; G: (Hussain et al., 2023) [26]; H: (Abal-Seqan et al., 2023) [27]; I: (Thneibat and Al-Shattarat, 2023) [28]; J: (Piwowar-Sulej and Iqbal, 2024) [29]; K: (Zia et al., 2024) [30]; L: (Amies et al., 2024) [31]; M: (Alqahtani et al., 2024) [32]; N: (Kineber et al., 2024) [33]. The 'v' symbol indicates the association of the respective author with the corresponding column. **Source:** This is an original table that was created by the authors for this paper.

Project management has become a common practice across industries because it can help organizations achieve their goals more effectively and efficiently [19]. Project management is very important for companies because it can help in maintaining quality control, maximizing existing human resources, creating a sequential and coherent process in project work, helping to understand success and failure in achieving goals and making the goals that have been set clearer and more focused. Superior execution capabilities in project management can increase success and competitive advantage [34]. Learning how to lead, support, and manage projects effectively can help an organization achieve its goals [34]. Project management competencies positively affect employee performance [35]. Project management consists of several stages: pre-project, feasibility, business studies, functional models, design and build, and implementation [36]. Each of these stages must be carried out with full consideration and calculation so that no project will fail.

2.2. Project Success

Project success is an objective measure of the extent to which a project has achieved its predetermined goals [37]. The measure of project success is the achievement of user expectations and needs [38]. The selection of performance measures and the setting of targets for the performance measures of a project will determine the strategy and guidelines for managing operational steps [39]. Performance measurement on a project includes budgeted costs, specified quality, and achievement of targeted time [1,17]. The final results achieved from a project reflect how successful the project management was [39]. Project success consists of three dimensions, namely, project management success, project ownership success, and project investment success [40].

Project success means meeting critical performance indicators, such as cost, schedule, quality, and stakeholder satisfaction [41]. The success of a construction project is measured on the basis of timely achievement, costs within budget, quality of work results, safety levels

during implementation, and client satisfaction with the project results [42]. The success of a construction project is measured through two main dimensions: project efficiency (short term, such as time, cost, and quality) and project effectiveness (long term, such as client satisfaction) [43]. Project completion on time, cost, quality, health and safety, environmental performance, participant satisfaction, user satisfaction, and commercial value [44]. The achievement of project success is measured based on the fulfillment of traditional criteria, such as cost, quality, time, and achievement of environmental and social sustainability [40]. The achievement of project results is measured through three main aspects, namely, time, cost, and quality, known as the “iron triangle”, where the project is considered successful if it can be completed on schedule, within budget, and meets the established quality standards [19]. All components of project success considered in this study are presented in Table 2, which outlines the main components of project success.

Table 2. Main components of project success.

Components/Authors	A	B	C	D	E	F	G	H	I
Time	v	v	v	v	v	v	v	v	v
Cost	v	v	v	v	v	v	v	v	v
Quality	v	v	v	v	v		v	v	v
Sustainability		v							
Stakeholder satisfaction			v		v	v	v	v	v
Safety				v		v		v	
Defects						v			
Profitability				v		v			
Customer satisfaction				v	v				
Workplace organization					v				
Health				v					
Environmental performance				v					
Participant satisfaction				v					
Customer expectation			v						

Note: A: (Zuo et al., 2018) [19]; B: (Zaman et al., 2020) [45]; C: (Waqar et al., 2023) [46]; D: 2024) [44]; E: (Sadikoglu et al., 2024) [47]; F: (Wood et al., 2024) [48]; G: (Mavi et al., 2024) [43]; H: (Polat, 2024) [42]; I: (Tetteh et al., 2024) [41]. The ‘v’ symbol indicates the association of the respective author with the corresponding column. **Source:** This is an original table that was created by the authors for this paper.

2.3. Human Capital Agility

Human capital refers to individuals’ skills, knowledge, and health that can be used to increase economic productivity [49]. Human capital is the investment, and human capital characteristics, such as tenure, education, age, and informal training at work, are used to explain wages based on this investment [50]. Human capital is a set of capabilities formed through personal development based on the active use of financial, social, intellectual, cultural, and creative resources [51]. Human capital is the collection of individual employee potentials that include physical, mental, intellectual, and moral capacities, developed by skills, knowledge, talent, and health [52]. Human capital is the intangible economic value of educational attainment, knowledge, experience, and skills that can increase productivity through education and workforce preparation [53].

Research related to human capital agility is currently relatively limited; there is only one paper on human capital agility in the Scopus database accessed on 22 May 2024. Subsequently, we analyzed the research paper and identified a lack of clarity, particularly due to the conflation of human capital agility with human resources agility. Therefore, in this study, we attempt to compile a definition of human capital agility that is a combination of the concepts of human capital and agility. In this study, the human capital component is

developed from Vidotto’s human capital component [54]. Agility is the ability to respond to change quickly (responsiveness), achieve goals optimally (effectiveness), and adapt to new conditions flexibly with minimal effort (flexibility) [55]. Agility is a set of behaviors that reflect the ability to actively face change (proactivity), adjust to new situations (adaptability), and be resilient when facing challenges (resilience) [56]. Agility is a set of characteristics that reflect the ability to actively take initiative (proactivity), adjust to change (adaptability), and create new or innovative solutions to challenges (generativity) [57]. All human capital components examined in this study are presented in Table 3, which outlines the main components of human capital.

Table 3. Human capital main components.

Components/Authors	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Talent				v									v	
Education	v	v	v	v					v		v			v
Experience	v	v		v		v	v	v	v	v				v
Knowledge	v	v	v	v	v	v	v	v	v	v		v	v	v
Skill	v	v	v	v	v	v	v	v	v	v		v	v	v
Attitudes			v	v	v	v	v		v					
Creativity						v		v	v					
Leadership									v					
Job tenure											v			
Age											v			
Informal on-the-job training											v			
Predispositions													v	
Health														v

Note: A: (Schultz, 1961a) [49]; B: (Mincer, 1962) [58]; C: (Becker, 1964) [59]; D: (Bontis, 1998) [60]; E: (O’Sullivan and Stankosky, 2004) [61]; F: (Subramaniam and Youndt, 2005) [62]; G: (Chen et al., 2009) [63]; H: (Huang and Wu, 2010) [64]; I: (Bueno et al., 2011) [65]; J: (Nieves and Haller, 2014) [66]; K: (Greer and Carden, 2021b) [50]; L: (Kaliyeva et al., 2022) [51]; M: (Kański et al., 2022) [52]; N: (Parrella et al., 2024) [53]. The ‘v’ symbol indicates the association of the respective author with the corresponding column. **Source:** This is an original table that was created by the authors for this paper.

Agility reflects the ability to remain resilient despite challenges (resilience), adapt to new situations (adaptability), and actively take the initiative in facing change (proactivity) [67]. From the explanation above, it can be arranged for a draft definition of human capital agility, which is composed of the following components: Talent, Education, Experience, Knowledge, Skill, Attitudes, Creativity, Leadership, Job tenure, Age, Informal on-the-job training, Predispositions, Health, Adaptability / Adaptive, Flexibility, Responsiveness, Proactivity, Resilience, Generative, and Effectiveness. All of the agility components examined in this study are presented in Table 4, which outlines the main components of agility.

Table 4. Main components of agility.

Components/Authors	A	B	C	D
Adaptability /Adaptive		v	v	v
Flexibility	v			
Responsiveness	v			
Proactivity		v	v	v
Resilience		v		v
Generative			v	
Effectiveness	v			

Note: A: (Dehghani Sadrabadi et al., 2023) [55]; B: (Petermann and Zacher, 2022) [56]; C: (Narenji Thani et al., 2022) [57]; D: (Almagharbeh, 2024) [67]. The ‘v’ symbol indicates the association of the respective author with the corresponding column. **Source:** This is an original table that was created by the authors for this paper.

2.4. Leadership Agility

Leadership agility refers to the ability to lead effectively under conditions of rapid change and high complexity [68]. Leadership agility refers to the ability of leaders to make decisions in a turbulent business environment, where information is limited, and there is a need to continuously interpret changing conditions, implement innovative solutions, and recover quickly from failures [69]. Leadership agility is the capacity of organizational leaders to drive strategic and operational agility and create an agile leadership culture while personally adapting to changing and interdependent daily conditions [13]. Leadership agility refers to the ability of a leader to lead effectively during rapid change, uncertainty, and increasing complexity while considering multiple perspectives and priorities to achieve success [70]. Leadership agility refers to the ability of a leader to adapt, be innovative, and be flexible in a dynamic and uncertain business environment [14].

Leadership agility refers to the ability of agile leadership to increase flexibility, adopt change, innovate, and responsiveness when facing difficult situations, such as a pandemic [71]. Leadership agility refers to the ability of agile leadership to maintain stability through collaboration with other teams, proactive awareness of expected and unexpected situations, and shared attention among team members when dealing with unexpected situations [72]. Leadership agility refers to leaders’ ability to help organizations respond quickly to unexpected changes, innovate, and adapt effectively despite complex situations [73]. Leadership agility is the ability to lead through change by adapting quickly, inspiring resilience, encouraging positive attitudes, and helping organizations thrive during dynamic shifts with high uniqueness and flexibility [74]. Leadership agility refers to leaders’ ability to manage continuous and complex changes and implement agility in an organization [75]. All components of leadership agility examined in this study are presented in Table 5, which outlines the main components of leadership agility.

From the definition above, the following components that make up leadership agility are obtained: Critical thinker, Emotionally intelligent, Anxiety-managing, Adaptable, Contextually intelligent, Resilient, Innovative, Speedy, Flexible, Sensitive, Creative, Sensing, Adoptive, Responsive, Effective in Recognizing Problems, Decisive, Collaborative, Change effectively, Active learner, Being a role model, Having a future-oriented mindset, and Anticipating change.

Table 5. Main components of leadership agility.

Components/Authors	A	B	C	D	E	F	G	H
Critical thinker	v							
Emotionally intelligent	v							
Anxiety-managing	v							
Adaptable	v	v	v		v	v	v	
Contextually intelligent	v							
Resilient	v		v				v	
Innovative			v	v		v		
Speedy			v					
Flexible			v	v	v	v	v	v
Sensitive			v					
Creative		v						
Sensing		v						
Adoptive				v				
Responsive				v		v		
Effective In Recognizing Problems					v			
Decisive					v			
Collaborative					v			v
Change effectively							v	
Active learner							v	
Being a role model							v	
Having future-oriented mindset							v	
Anticipate change								v

Note: A: (Saleh and Watson, 2017) [68]; B: (Joiner, 2019) [13]; C: (Zulkifli et al., 2021) [14]; D: (Aftab et al., 2022) [71]; E: (Prasetyo et al., 2022a) [72]; F: (Arghode et al., 2023) [73]; G: (Juliana et al., 2024b) [74]; H: (Tandon et al., 2024) [75]. The ‘v’ symbol indicates the association of the respective author with the corresponding column. **Source:** This is an original table that was created by the authors for this paper.

3. Research Methodology

3.1. Focus Group Discussion

Focus Group Discussion (FGD) is generally conducted face-to-face to facilitate direct interaction between participants [76]. FGD is a very useful method, especially for collecting data from communities that are difficult to access or have high mobility, where organizing meetings in certain locations is often a challenge [77]. However, FGD can be performed online using various tools and platforms. Online FGD can be conducted to collect qualitative data from various participants who are geographically spread out [78]. Various applications, such as Google Meet and Microsoft Teams, are commonly used. Platforms such as Microsoft Teams can be used as effective communication media. Microsoft Teams allow automatic audio recording with fairly good quality without the need for additional devices, making it easier to document group discussions [76]. This allows for the implementation of an FGD hybrid (partly online and offline). The FGD method in this study was conducted face-to-face, allowing participants to be directly involved and to feel the dynamics of the discussion optimally. The number of participants in a Focus Group Discussion (FGD) ranges from 4 to 12 people [79]. The selection of participants was carried out using the purposive or convenience sampling method, where we considered the representation of large- and small-scale construction companies that could provide relevant insights and information [79]. The respondents selected for this study were highly experienced professionals occupying top-level management positions. Their selection was

based on their strategic perspectives and comprehensive expertise, ensuring their ability to provide valuable insights. Furthermore, they met predefined criteria, including educational qualifications, area of specialization, professional experience, and willingness to participate in this study. All participants involved in this study are listed in Table 6, which presents the list of industrial practitioners.

Table 6. List of industrial practitioners.

Industrial Practitioners	Position	Education	Length of Work in the Construction Sector
IP1	Director	Master's Degree	0–5 years
IP2	General Manager	Master's Degree	16–25 years
IP3	Director	Bachelor's Degree	0–5 years
IP4	Director	Master's Degree	Over 25 years
IP5	General Manager	Bachelor's Degree	0–5 years
IP6	Director	Bachelor's Degree	Over 25 years
IP7	Director	Doctoral Degree	Over 25 years

To ensure a flow of discussion in the FGD, questions should be structured. Mohd Kassim et al. [76] divides FGD questions into four parts: Opening Questions to introduce this study and introduce participants, Warm-up Questions to explore basic concepts related to the topic, Main Questions to explore core research information, and Closing Questions to obtain additional information and summarize the discussion. In another approach, FGD questions can be divided into three parts: opening and warm-up, stakeholder dynamics for the process stage, and closing [80].

Kumari et al. [81] developed a guide for implementing FGD to ensure the consistency and quality of the obtained data. The steps include seven important steps, namely, (1) identification of participants through purposive sampling; (2) data collection using video conferencing (such as: Google Meet); (3) discussion guided by a moderator; (4) verbatim transcription of the discussion; (5) identification of initial codes through an inductive process; (6) arranging codes into sub-themes; and (7) identification of main themes for data analysis. This study combines two FGD methods, where FGD questions are divided into four parts as carried out by Mohd Kassim et al. [76] and seven steps as carried out by Kumari et al. [81], but in step (2) in this study it was conducted face to face. The implementation of FGD in this study involved seven practitioners from the construction sector, more details can be seen in Table 6.

The process of implementing the FGD in this study was carried out with a series of protocols and questions that were prepared and arranged systematically (see Appendices A.1 and A.2). Each participant's response ended with a conclusion from the moderator, which was understood by all participants. The discussion was recorded in audio format using an electronic audio recorder and then transcribed verbatim. The transcript was thoroughly refined to answer questions related to human capital agility, leadership agility, and project success.

3.2. Fuzzy Delphi Method

The Delphi method was first developed in 1948 by the Rand Corporation as a decision analysis method that relies on the professional knowledge, experience, and judgment of expert participants [82]. This method is often applied to achieve consensus through expert group discussions in multi-criteria decision-making [83]. However, to handle the uncertainties and linguistic variables that often arise in human-based assessments, the Fuzzy Delphi Method (FDM) was developed as a combination of fuzzy theory and the

Delphi method [82]. FDM uses fuzzy theory to validate the consensus reached from expert assessments, thereby increasing the validity of feature quantification process [83].

FDM is often used in the process of filtering less important attributes, where attributes are assessed in the form of qualitative information with linguistic preferences [84]. FDM is growing in popularity as an effective approach to help managers solve real-life problems in both business and management contexts [84]. In this study, FDM is applied to evaluate the attributes (components) of Human capital agility, Leadership agility, and Project success by converting linguistic scores into fuzzy numbers which can then be defuzzified to achieve more precise values [83]. Methodologically, FDM integrates fuzzy theory with the Delphi method to ensure that expert opinions have reached convergence, using the triangular fuzzy number (TFN) approach and gray relational degree as analysis mechanisms [85]. The triangular fuzzy numbers (TFN) utilized in this study are presented in Table 7.

Table 7. Triangular fuzzy numbers (TFN).

Linguistic Variable	Triangular Fuzzy Number (a, b, c)
Absolutely Unimportant	(0.0, 0.0, 0.1)
Unimportant	(0.0, 0.1, 0.3)
Slightly Unimportant	(0.1, 0.3, 0.5)
Neutral	(0.3, 0.5, 0.7)
Slightly Important	(0.5, 0.7, 0.9)
Important	(0.7, 0.9, 1.0)
Absolutely Important	(0.9, 1.0, 1.0)

This process includes three main steps: input preparation, data analysis, and final decision [86]. At the input preparation stage, data are collected by creating questionnaires and selecting experts based on certain criteria, such as education level, field of expertise, and experience [86]. Okoli and Pawlowski [87] explained that the Delphi method is a group decision-making mechanism that does not rely on statistical samples but instead depends on experts with a deep understanding of the issues, making the selection of qualified experts critically important. This study involves seven practitioners selected on the basis of their extensive experience and in-depth understanding of the Indonesian construction sector.

The data analysis stage in FDM consists of three procedures: (1) converting qualitative scales to fuzzy scales, (2) calculating threshold values and percentages of agreement, and (3) defuzzification to produce precise (crisp) numbers [86]. Through this approach, the uncertainty inherent in expert evaluation can be better managed; thus, FDM is considered suitable for research that requires consensus based on subjective and ambiguous judgments [88].

The FDM process can also include a literature review, expert evaluation, and analysis stages. These steps are applied to evaluate the dimensions, factors, and measures of e-learning readiness, where FDM involves two main steps: designing a questionnaire and analyzing data to reach agreement between experts [86]. In other cases, FDM is applied in long-term prediction, where the question involves estimating periods from unlikely to highly probable [89].

The application of FDM in this study follows the following procedures:

Step 1: Expert opinion collection was conducted by distributing questionnaires to seven experts from the construction sector who met certain criteria such as education level, field of expertise, experience, and willingness to participate in this study. This questionnaire was divided into three parts: demographics, assessment of attributes (components) of the dimensions of human capital agility, leadership agility and project success, and linguistic preferences used as a reference for the fuzzy scale Chang et al. [90] and Mohd Khalli et al. [91].

Linguistic preferences are converted into triangular fuzzy numbers (TFN) with values that include three parameters: minimum (a), average (b), and maximum (c) for each attribute. Step 2: At this stage, the importance value of each attribute (component) is calculated based on the triangular fuzzy numbers obtained from expert opinions. Each attribute is assessed using the following triangular fuzzy number formula:

$$\tilde{A}_{ij} = (a_{ij}, b_{ij}, c_{ij}), I = 1, 2, \dots, n; J = 1, 2, \dots, m, \quad (1)$$

where $\tilde{A}_{ij}$ represents the fuzzy value of the attribute given by each expert for each dimension, with a, b, and c, respectively, as the minimum, average, and maximum values of the respondents' consensus. Next, the average fuzzy value for each attribute is calculated using the following formula:

$$\tilde{F}_j = (a_j, b_j, c_j) = \left(\min\{a_{ij}\}, \frac{1}{n} \sum_{i=1}^n b_{ij}, \max\{c_{ij}\} \right), \quad (2)$$

where $\tilde{F}_j$ is the average fuzzy value for each attribute after combining the assessments of all experts. Then, to obtain the precision value, a defuzzification process is carried out using the center of gravity method with the following formula:

$$D_j = \frac{a_j + b_j + c_j}{3}, j = 1, 2, \dots, m, \quad (3)$$

where D_j is the crisp (precision) value after defuzzification, which represents the final value of the evaluated attribute.

Step 3: After the crisp value is obtained for each attribute, the final step is to determine whether the attribute is accepted or rejected based on the threshold value (γ). The threshold value (γ) is calculated as the average of the crisp values of all attributes, using the following formula:

$$\gamma = \sum_{j=1}^m \left(\frac{D_j}{m} \right), \quad (4)$$

If the crisp value D_j of an attribute is greater than the threshold γ , then the attribute is accepted. Conversely, if D_j is less than γ , the attribute is rejected. This step helps filter out less relevant attributes and ensures that only attributes with significant consensus from experts are included in the final analysis. Although widely applied in various disciplines, such as humanities, business, science, and engineering, FDM has important limitations that require further analytical or experimental verification to prove its effectiveness in achieving consensus in group decision-making [92]. The application of the Fuzzy Delphi Method (FDM) in this study follows the procedures illustrated in Figure 1. This figure presents the flowchart of the FDM application in this research.

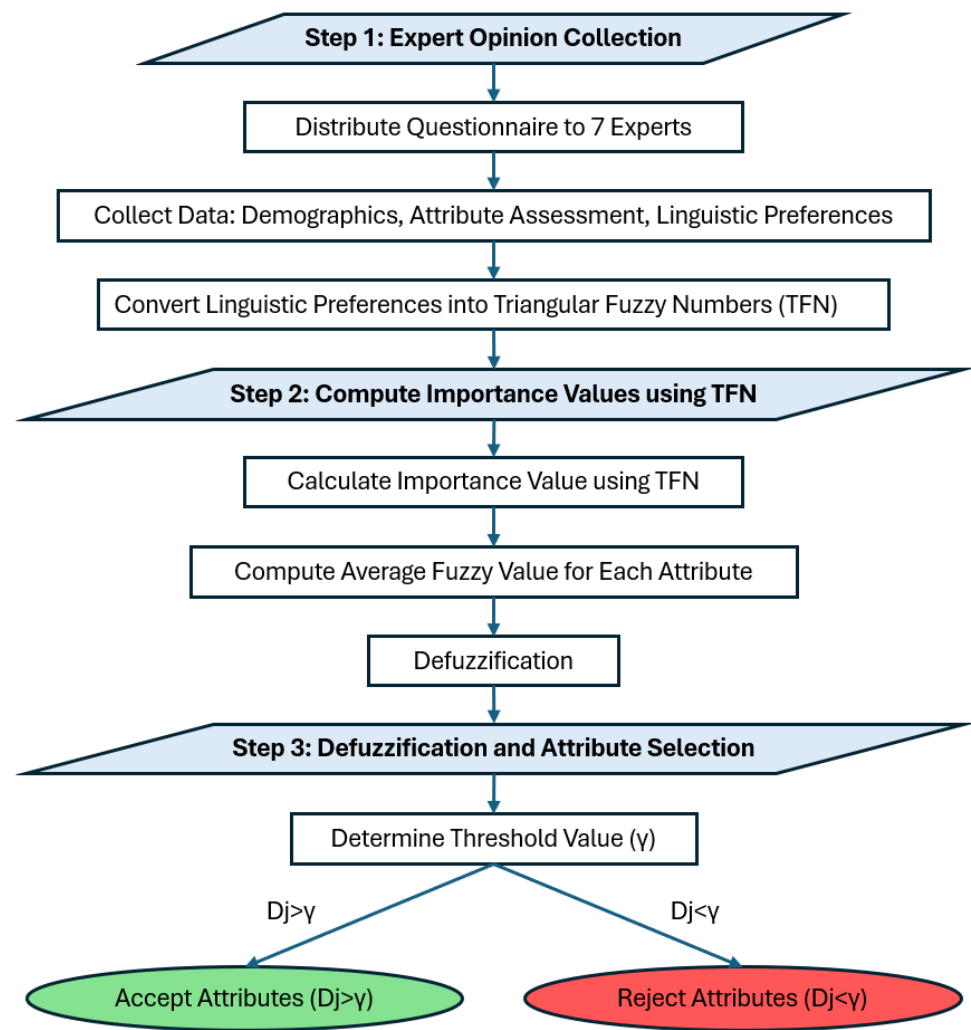


Figure 1. Flowchart of the application of FDM in this research.

4. Results and Discussion

4.1. Project Success

Based on the results of the FGD implementation and the processing of the Fuzzy Delphi Method (FDM) for the components that build Project Success, it can be concluded that there are several key components that have a significant influence on the success of a construction project. The scores calculated from the minimum, average, maximum, and defuzzification values indicate that each component has an important contribution in ensuring the achievement of project success. The description of each project success component analyzed in this study is presented in Table 8, which outlines the initial components of project success.

Table 8. Initial components of project success.

Components	Description	Authors
Time	A project is successful if it can be completed according to the planned schedule, without significant delays and according to the set time target.	(Borges et al., 2024; Mavi et al., 2024; Polat, 2024; Sadikoglu et al., 2024; Tetteh et al., 2024; Waqar et al., 2023; Wood et al., 2024; Zaman et al., 2020; Zuo et al., 2018) [19,41–48]
Cost	Project success is measured by its ability to be completed within the set budget, by optimizing the use of resources to avoid cost overruns.	(Borges et al., 2024; Mavi et al., 2024; Polat, 2024; Sadikoglu et al., 2024; Tetteh et al., 2024; Waqar et al., 2023; Wood et al., 2024; Zaman et al., 2020; Zuo et al., 2018) [19,41–48]
Quality	A project is considered successful if the final result meets or exceeds the set quality standards, both in terms of technical specifications and end-user satisfaction.	(Borges et al., 2024; Mavi et al., 2024; Polat, 2024; Sadikoglu et al., 2024; Tetteh et al., 2024; Waqar et al., 2023; Zaman et al., 2020; Zuo et al., 2018) [19,41–47]
Sustainability	A project is considered successful if it considers the long-term impact on the environment and contributes to overall social, economic, and ecological sustainability.	(Zaman et al., 2020) [45]
Stakeholder satisfaction	A project's success depends on the level of satisfaction of stakeholders, including clients, stakeholders, and other parties involved or affected by the project.	(Mavi et al., 2024; Polat, 2024; Sadikoglu et al., 2024; Tetteh et al., 2024; Waqar et al., 2023; Wood et al., 2024; Zuo et al., 2018) [19,41–43,46–48]
Safety	A project is considered successful if it is implemented by minimizing the risk of accidents and maintaining the health and safety of all workers involved during the project implementation.	(Borges et al., 2024; Polat, 2024; Wood et al., 2024) [42,44,48]
Defects	A project's success is measured by the minimum level of defects or deficiencies in the final result, which indicates that the project was carried out with good quality control.	(Wood et al., 2024) [48]
Profitability	A project is considered successful if it can generate benefits for related parties, especially the company carrying out the project, both in terms of finance and other added value.	(Borges et al., 2024; Wood et al., 2024) [44,48]
Customer satisfaction	Customer satisfaction is very important in determining the success of a project, where the project results are in accordance with the expectations, needs, and desires of customers or end users.	(Borges et al., 2024; Sadikoglu et al., 2024) [44,47]
Workplace organization	Good work organization, including team management and structured workflows, are indicators of success in facilitating efficiency and productivity during the project.	(Sadikoglu et al., 2024) [47]
Health	A project is considered successful if it not only pays attention to technical results, but also the physical and mental health of workers, and maintains the welfare of the workforce involved in the project.	(Borges et al., 2024) [44]
Environmental performance	Good environmental performance is a benchmark for success, where the project does not damage the surrounding environment and instead provides a positive, sustainable impact on the ecosystem.	(Borges et al., 2024) [44]
Participant satisfaction	Project success is also seen from the level of satisfaction of participants, both workers and collaborators, who feel positively involved and treated well during the project.	(Borges et al., 2024) [44]
Customer expectation	A successful project is one that is able to meet or even exceed customer expectations, providing results that are in accordance with expectations or better than initial expectations.	(Waqar et al., 2023) [46]

The calculation results show that the components with the highest scores are Time, Quality, Profitability, and Health, all of which have very high defuzzification scores of

around 0.8952. Next, Cost and Safety have defuzzification scores of 0.8905, placing them in second place. The next components are Defects, Sustainability, and Stakeholder Satisfaction with a defuzzification score of 0.8857, placing them in third place. In fourth place, with a defuzzification score of 0.8810, are Customer Satisfaction, Environmental Performance, and Customer Expectation. Lastly, Workplace Organization and Participant Satisfaction, with lower defuzzification scores (0.8095 and 0.8048, respectively), ranked fifth and sixth, still contributing to the success of the project. Details of the calculation results for project success components are presented in Table 9, which contains data from processing the selection of project success components.

Table 9. Data from processing the selection of project success components.

Components	Score				Rank	Result
	Min.	Avg.	Max.	De-Fuzzy		
Time	0.70	0.99	1.00	0.8952	1	Accepted
Quality	0.70	0.99	1.00	0.8952	1	Accepted
Profitability	0.70	0.99	1.00	0.8952	1	Accepted
Health	0.70	0.99	1.00	0.8952	1	Accepted
Cost	0.70	0.97	1.00	0.8905	2	Accepted
Safety	0.70	0.97	1.00	0.8905	2	Accepted
Defects	0.70	0.96	1.00	0.8857	3	Accepted
Sustainability	0.70	0.96	1.00	0.8857	3	Accepted
Stakeholder satisfaction	0.70	0.96	1.00	0.8857	3	Accepted
Customer satisfaction	0.70	0.94	1.00	0.8810	4	Accepted
Environmental performance	0.70	0.94	1.00	0.8810	4	Accepted
Customer expectation	0.70	0.94	1.00	0.8810	4	Accepted
Workplace organization	0.50	0.93	1.00	0.8095	5	Accepted
Participant satisfaction	0.50	0.91	1.00	0.8048	6	Accepted

4.2. Human Capital Agility

Based on the results of the Fuzzy Delphi Method (FDM) processing for the components of Human Capital Agility, the human capital agility variable is formed from two main variables: Human Capital and Agility.

4.2.1. Human Capital

The first most influential component is Attitudes, with the highest defuzzification value of 0.89524. Below attitudes, there is Knowledge with a defuzzification score of 0.88095. Sufficient and relevant knowledge in the context of the project allows individuals to quickly adapt to the various challenges that exist. The description of each human capital agility component analyzed in this study is presented in Table 10, which outlines the initial components of human capital agility.

Table 10. Initial components of human capital agility.

Components	Description	Authors
Talent	An individual's unique innate abilities, which can be developed through training and experience. This includes natural potential that allows an individual to excel in a particular role.	(Bontis, 1998; Kański et al., 2022) [52,60]
Education	An individual's formal background, which includes academic degrees and certifications. Education provides the theoretical and knowledge base that aids in the development of technical and professional skills.	(Becker, 1964; Bontis, 1998; Bueno et al., 2011; Greer and Carden, 2021b; Mincer, 1962; Parrella et al., 2024; Schultz, 1961a) [49,50,53,58–60,65]
Experience	An individual's direct involvement in a particular job or situation over a period of time. This includes practical knowledge gained through practice and repetition in a work environment.	(Bontis, 1998; Bueno et al., 2011; Chen et al., 2009; Huang and Wu, 2010; Mincer, 1962; Nieves and Haller, 2014; Parrella et al., 2024; Schultz, 1961a; Subramaniam and Youndt, 2005) [49,53,58,60,62–66]
Knowledge	An individual's understanding or insight into a field or topic. Knowledge can be theoretical or practical and plays a significant role in decision-making.	(Becker, 1964; Bontis, 1998; Bueno et al., 2011; Chen et al., 2009; Huang and Wu, 2010; Kaliyeva et al., 2022; Kański et al., 2022; Mincer, 1962; Nieves and Haller, 2014; O'Sullivan and Stankosky, 2004; Parrella et al., 2024; Schultz, 1961a; Subramaniam and Youndt, 2005) [49,51–53,58–66]
Skill	An ability learned and developed through practice to perform a specific task with efficiency and effectiveness. Skills can be technical or non-technical, such as communication or leadership.	(Becker, 1964; Bontis, 2016; Bueno et al., 2011; Chen et al., 2009; Huang and Wu, 2010; Kaliyeva et al., 2022; Kański et al., 2022; Mincer, 1962; Nieves and Haller, 2014; O'Sullivan and Stankosky, 2004; Parrella et al., 2024; Schultz, 1961a; Subramaniam and Youndt, 2005) [49,51–53,58,59,61–66,93]
Attitudes	An individual's outlook or mental disposition toward a job, team, or work environment. A positive attitude usually helps create a conducive and productive work environment.	(Becker, 1964; Bontis, 1998; Bueno et al., 2011; Chen et al., 2009; O'Sullivan and Stankosky, 2004; Subramaniam and Youndt, 2005) [59–63,65]
Creativity	The ability to generate new and innovative ideas and find unconventional solutions to problems. This is especially important in organizations that strive to innovate and adapt to change.	(Bueno et al., 2011; Huang and Wu, 2010; Subramaniam and Youndt, 2005) [62,64,65]
Leadership	An individual's ability to motivate, direct, and guide others in achieving common goals. Leadership involves decision-making, strategic vision, and managing teams.	(Bueno et al., 2011) [65]
Job tenure	The length of time an individual has been in a role or organization. The longer a person has been in a position or company, the more likely they are to have a deeper understanding and insight into the job or organization, which increases their productivity and contribution.	(Greer and Carden, 2021b) [50]
Age	Age is often associated with experience, maturity, and emotional stability; however, it can also affect adaptability to new technologies or more modern working methods.	(Greer and Carden, 2021b) [50]
Informal on-the-job training	Learning that occurs in the workplace, outside of formal training structures. Employees learn through direct experience, observation, and interaction with colleagues, which can significantly improve their practical skills.	(Greer and Carden, 2021b) [50]
Predispositions	Innate tendencies refer to the natural traits or personality traits of an individual that influence how they work and interact in a professional environment. This includes characteristics such as ambition, initiative or the ability to adapt to change.	(Kański et al., 2022) [52]

Table 10. Cont.

Components	Description	Authors
Health	An individual's health affects their ability to work productively and consistently. Good physical and mental health allows individuals to focus, work longer hours and reduces the likelihood of absenteeism or illness.	(Kański et al., 2022) [52]
Adaptability/Adaptive	Readiness to adapt quickly to changing circumstances or unexpected demands in the work environment.	(Almagharbeh, 2024; Narenji Thani et al., 2022; Petermann and Zacher, 2022) [56,57,67]
Flexibility	The ability to adapt or change approaches, strategies, or actions to meet new needs or changing situations.	(Dehghani Sadrabadi et al., 2023) [55]
Responsiveness	The ability to adapt quickly to changes in the environment or marketplace, including making decisions and acting in a timely manner.	(Dehghani Sadrabadi et al., 2023) [55]
Proactivity	The ability to anticipate or control situations, rather than simply waiting to react to events as they occur.	(Almagharbeh, 2024; Narenji Thani et al., 2022; Petermann and Zacher, 2022) [56,57,67]
Resilience	The ability to recover or bounce back from stress, adversity, or challenges.	(Almagharbeh, 2024; Petermann and Zacher, 2022) [56,67]
Generative	The ability to generate new ideas, solutions, or innovations that can be used to address challenges in the workplace or on projects.	(Narenji Thani et al., 2022) [57]
Effectiveness	The ability to achieve desired goals efficiently using available resources.	(Dehghani Sadrabadi et al., 2023) [55]

Talent is ranked third with a defuzzification score of 0.87143. Several other components that show medium scores in the human capital category are Experience and Leadership, each of which has a defuzzification score of 0.81429. Skill and Health each have a defuzzification score of 0.80952. Education and Creativity are ranked next with defuzzification scores of 0.80476 and 0.79048, respectively, and the last component accepted as part of human capital is Predispositions with a defuzzification score of 0.78095. Details of the calculation results for human capital agility components are presented in Table 11, which contains data from processing the selection of human capital agility components.

Table 11. Data from processing the selection of human capital agility components.

Variables	Components	Score				Rank	Result
		Min.	Avg.	Max.	De-Fuzzy		
Human Capital	Attitudes	0.700	0.986	1.000	0.89524	1	Accepted
	Knowledge	0.700	0.943	1.000	0.88095	2	Accepted
	Talent	0.700	0.914	1.000	0.87143	3	Accepted
	Experience	0.500	0.943	1.000	0.81429	4	Accepted
	Leadership	0.500	0.943	1.000	0.81429	4	Accepted
	Skill	0.500	0.929	1.000	0.80952	5	Accepted
	Health	0.500	0.929	1.000	0.80952	5	Accepted
	Education	0.500	0.914	1.000	0.80476	6	Accepted
	Creativity	0.500	0.871	1.000	0.79048	7	Accepted
	Predispositions	0.500	0.843	1.000	0.78095	8	Accepted
	Informal on-the-job training	0.300	0.800	1.000	0.70000	9	Not Accepted
	Job tenure	0.300	0.700	1.000	0.66667	10	Not Accepted
	Age	0.300	0.700	1.000	0.66667	10	Not Accepted

Table 11. Cont.

Variables	Components	Score				Rank	Result
		Min.	Avg.	Max.	De-Fuzzy		
Agility	Flexibility	0.700	0.971	1.000	0.89048	1	Accepted
	Responsiveness	0.700	0.971	1.000	0.89048	1	Accepted
	Proactivity	0.700	0.971	1.000	0.89048	1	Accepted
	Adaptability	0.700	0.957	1.000	0.88571	2	Accepted
	Resilience	0.700	0.957	1.000	0.88571	2	Accepted
	Effectiveness	0.700	0.957	1.000	0.88571	2	Accepted
	Generative	0.500	0.886	1.000	0.79524	3	Accepted

Meanwhile, Informal on-the-job training, as well as Job tenure and Age, showed lower scores and were not accepted in the FDM, with defuzzification scores below 0.75. This shows that, although these factors have a role, they are not significantly part of human capital in the context of construction projects.

4.2.2. Agility

As shown in Table 10, data from processing the selection of human capital agility components can be seen specifically in the agility dimension. The most important components are flexibility, responsiveness, and proactivity, all of which obtained a defuzzification score of 0.89048. These three components greatly support the ability of individuals or teams to respond to rapid changes and anticipate problems before they develop further. Adaptability, resilience, and effectiveness also showed high values with a defuzzification score of 0.88571. The last component is generative, which obtained a defuzzification score of 0.79524. This reflects the ability to create new ideas and innovative solutions in facing challenges, although its influence is slightly lower compared to the other components.

4.3. Leadership Agility

Based on the results of the Fuzzy Delphi Method (FDM) processing for the selection of Leadership Agility components, leadership agility can be understood as a combination of a number of components that form a project manager's ability to lead a team in facing project dynamics and uncertainty. The description of each leadership agility component analyzed in this study is presented in Table 12, which outlines the initial components of leadership agility.

Table 12. Initial components of leadership agility.

Components	Description	Authors
Critical thinker	The ability to objectively analyze and evaluate information, identify logical relationships, and effectively solve complex problems.	(Saleh and Watson, 2017) [68]
Emotionally intelligent	The ability to recognize, understand, and manage emotions in self and others to build stronger relationships and make informed decisions.	(Saleh and Watson, 2017) [68]
Anxiety-managing	Anxiety management and control skills to maintain focus and performance during stressful or uncertain situations.	(Saleh and Watson, 2017) [68]
Adaptable	The ability to adapt to new circumstances, roles, or environments quickly and efficiently, remains effective despite change.	(Arghode et al., 2023; Joiner, 2019; Juliana et al., 2024b; Prasetyo et al., 2022a; Saleh and Watson, 2017; Zulkifli et al., 2021) [13,14,68,72–74]

Table 12. Cont.

Components	Description	Authors
Contextually intelligent	The ability to read and interpret situational variables and apply appropriate strategies based on context and complexity.	(Saleh and Watson, 2017) [68]
Resilient	The ability to bounce back from setbacks, challenges, or adversity while remaining focused on goals and objectives.	(Juliana et al., 2024b; Saleh and Watson, 2017; Zulkifli et al., 2021) [14,68,74]
Innovative	The ability to generate creative ideas and implement new solutions to overcome obstacles or exploit new opportunities.	(Aftab et al., 2022; Arghode et al., 2023; Zulkifli et al., 2021) [14,71,73]
Speedy	The ability to respond and act quickly to changing circumstances, maintaining momentum to achieve timely results.	(Zulkifli et al., 2021) [14]
Flexible	The ability to change approaches, methods, or strategies as needed to accommodate evolving demands or circumstances.	(Aftab et al., 2022; Arghode et al., 2023; Juliana et al., 2024b; Prasetyo et al., 2022a; Tandon et al., 2024; Zulkifli et al., 2021) [14,71–75]
Sensitive	The ability to sense and respond appropriately to the needs, emotions, and concerns of others within the organization.	(Zulkifli et al., 2021) [14]
Creative	The ability to generate original and unconventional ideas or solutions to solve problems or improve processes.	(Joiner, 2019) [13]
Sensing	The ability to detect subtle signals or trends within an organization or market and respond proactively to emerging opportunities or threats.	(Joiner, 2019) [13]
Adoptive	The capacity to embrace and implement new practices, technologies or ideas to improve performance or meet new challenges.	(Aftab et al., 2022) [71]
Responsive	The ability to react quickly and appropriately to external stimuli or feedback, ensuring timely and effective decision-making.	(Aftab et al., 2022; Arghode et al., 2023) [71,73]
Effective In Recognizing Problems	The ability to identify potential problems or challenges early and accurately, enabling timely intervention and resolution.	(Prasetyo et al., 2022a) [72]
Decisive	The ability to make clear and confident decisions quickly, even under pressure or in uncertain situations.	(Prasetyo et al., 2022a) [72]
Collaborative	The capacity to work well with others, fostering cooperation and collaboration to achieve common goals.	(Prasetyo et al., 2022a; Tandon et al., 2024) [72,75]
Change effectively	The ability to implement change within the organization smoothly, ensuring minimal disruption while achieving desired outcomes.	(Juliana et al., 2024b) [74]
Active learner	A commitment to continuous learning and self-improvement by seeking new knowledge and experiences to enhance leadership capabilities.	(Juliana et al., 2024b) [74]
Being a role model	Demonstrates behaviors, values and practices that are exemplary for others in the organization.	(Juliana et al., 2024b) [74]
Having future-oriented mindset	The ability to think strategically about long-term goals, anticipate future trends and prepare the organization for upcoming challenges or opportunities.	(Juliana et al., 2024b) [74]
Anticipate change	The ability to forecast and prepare for potential changes in the environment, enabling a proactive rather than reactive strategy.	(Tandon et al., 2024) [75]
Critical thinker	The ability to objectively analyze and evaluate information, identify logical relationships, and effectively solve complex problems.	(Saleh and Watson, 2017) [68]

The components accepted to form the Leadership Agility variable are those with a defuzzification score higher than 0.75, whereas components with a score below 0.75 are not included in the final selection. Among all components, Resilient emerges as the highest-scoring attribute in Leadership Agility, achieving a defuzzification score of 0.89524. Following closely behind, Emotionally Intelligent, Adaptable, and Responsive share the same defuzzification score of 0.89048, indicating their strong relevance to the variable. Being a Role Model ranks next with a defuzzification score of 0.88571, while Decisive also holds a high position with a score of 0.88095. Several other components, though exhibiting slightly lower defuzzification values, remain within the acceptable range, such as Effective in Recognizing Problems (0.81429) and Having a Future-Oriented Mindset (0.80952). Additionally, Creative, Collaborative, Change Effectively, and Anticipate Change all share a defuzzification score of 0.80476, further emphasizing their significance in Leadership Agility. Meanwhile, Critical Thinker, Contextually Intelligent, and Flexible attain relatively high scores of 0.80000, demonstrating their essential role in the construct. Finally, the last component included in Leadership Agility is Sensitive, which, although ranking the lowest among the accepted components, still holds a notable score of 0.79048. Details of the calculation results for leadership agility components are presented in Table 13, which contains data from processing the selection of leadership agility components.

Table 13. Data from processing the selection of leadership agility components.

Components	Score				Rank	Result
	Min.	Avg.	Max.	De-Fuzzy		
Resilient	0.70	0.99	1.00	0.89524	1	Accepted
Emotionally intelligent	0.70	0.97	1.00	0.89048	2	Accepted
Adaptable	0.70	0.97	1.00	0.89048	2	Accepted
Responsive	0.70	0.97	1.00	0.89048	2	Accepted
Being a role model	0.70	0.96	1.00	0.88571	3	Accepted
Decisive	0.70	0.94	1.00	0.88095	4	Accepted
Effective in recognizing problems	0.50	0.94	1.00	0.81429	5	Accepted
Having future-oriented mindset	0.50	0.93	1.00	0.80952	6	Accepted
Creative	0.50	0.91	1.00	0.80476	7	Accepted
Collaborative	0.50	0.91	1.00	0.80476	7	Accepted
Change effectively	0.50	0.91	1.00	0.80476	7	Accepted
Anticipate change	0.50	0.91	1.00	0.80476	7	Accepted
Critical thinker	0.50	0.90	1.00	0.80000	8	Accepted
Contextually intelligent	0.50	0.90	1.00	0.80000	8	Accepted
Flexible	0.50	0.90	1.00	0.80000	8	Accepted
Active learner	0.50	0.89	1.00	0.79524	9	Accepted
Sensitive	0.50	0.87	1.00	0.79048	10	Accepted
Anxiety-managing	0.30	0.90	1.00	0.73333	11	Not Accepted
Innovative	0.30	0.87	1.00	0.72381	12	Not Accepted
Speedy	0.30	0.87	1.00	0.72381	12	Not Accepted
Adoptive	0.30	0.86	1.00	0.71905	13	Not Accepted
Sensing	0.30	0.81	1.00	0.70476	14	Not Accepted

There are several components that are not accepted because they have a defuzzification score below 0.75, namely Anxiety-managing, Innovative, Speedy, Adoptive, and Sensing.

These components, although they can play a role in the broader context of leadership, are not deep enough to influence leadership agility in construction projects.

The findings of this study conclusively address the research question by identifying and validating the critical components that shape human capital agility, leadership agility, and project success in Indonesia's construction sector. Through the application of the Fuzzy Delphi Method (FDM), this study has successfully refined 17 key components of human capital agility, emphasizing flexibility, responsiveness, proactivity, and adaptability as primary elements. Leadership agility is also characterized by essential components such as resilience, emotional intelligence, adaptability, and responsive confirming its role in enhancing project outcomes. This study redefines project success beyond the traditional parameters of time, cost, and quality, incorporating profitability, health, safety, defects, sustainability, stakeholder satisfaction, and environmental performance as fundamental dimensions. The high defuzzification scores of key factors, including time, quality, profitability, and health, demonstrate their significance in determining project success. Given these comprehensive findings, it is evident that this study has fully answered the research question and provides a strategic framework for improving agility and project performance in Indonesia's construction industry.

The findings of this study, which focus on the construction sector in Indonesia, have potential applicability across various industries facing similar challenges in dynamic and uncertain environments. Sectors such as manufacturing, healthcare, and information technology, which also require leadership agility, and human capital agility, could benefit from the insights gained in this research. The validated components of Human Capital Agility and Leadership Agility may serve as a foundation for organizations in these industries to enhance workforce responsiveness, optimize project execution, and improve overall performance. Future studies could further investigate the extent to which these findings translate into different industrial settings, allowing for broader generalizability and refinement of the proposed components.

5. Limitations and Future Research

This study provides practitioners with insights into how Human Capital Agility and Leadership Agility components can impact project success. By leveraging these components, practitioners can identify opportunities to improve project success. While the practical application of this model is beyond the direct scope of this study, our findings provide actionable insights for industry practitioners. For instance, construction companies can utilize the validated components of Human Capital Agility and Leadership Agility to enhance project success by focusing on strategic workforce development and adaptive leadership training. The identified agility dimensions (e.g., flexibility, proactivity, and resilience) can be integrated into project management frameworks to improve responsiveness in volatile construction environments. Furthermore, the results can inform HR and leadership training programs aimed at strengthening the agility of project managers in dealing with industry challenges. Future research will further explore these applications through empirical validation in real-world construction projects. Beyond these applications, it is also essential to understand how other project management factors interact with Human Capital Agility and Leadership Agility in determining project success.

Within the realm of Critical Success Factors (CSFs) in project management, five primary categories have been identified: project-related factors, consultant-related factors, work-environment-related factors, human capital-related factors, and leadership-related factors. This study primarily focuses on human capital and leadership-related factors. Future research should extend its scope to explore the remaining three categories: project-related factors, consultant-related factors, and work-environment-related factors. Investigating

these additional variables will provide a more comprehensive understanding of the key determinants of project success.

The existing research on Human Capital Agility is extremely limited, with only one notable study by Taji et al. (2023) [16]. However, this study defines Human Capital Agility by referencing sources that primarily discuss Human Resource Agility, leading to a lack of clarity in distinguishing these two concepts. This paper addresses this gap by constructing a more precise definition of Human Capital Agility, ensuring that it is rooted in the principles of human capital rather than human resource management. Additionally, this study explores the development of definitions for Leadership Agility and Project Success based on recent research that has contributed to the establishment of new conceptual frameworks. By integrating the updated literature and refining these definitions, this study offers a novel perspective that enhances the theoretical foundation of agility in project management.

This study has several limitations, namely, the process of identifying the components of the variables discussed only using the Scopus database. Second, the scope of this study covers only the construction sector in Indonesia; thus, the results may not be fully applicable to other sectors or countries. Third, the number of participants in the Focus Group Discussion (FGD) and Fuzzy Delphi Method (FDM) was limited to seven practitioners; although sufficient for the methodology used, it remains a limitation in terms of generalizing the results. Fourth, the Fuzzy Delphi Method (FDM) method relies on expert judgment, which may introduce subjectivity and bias. To minimize this, structured expert selection and predefined evaluation criteria were applied. Although these measures enhance objectivity, some degree of subjectivity remains inherent in the method.

In future research, the scope of this study should be expanded to other sectors and countries to test the validity of the proposed framework. While this study has primarily explored the impact of Human Capital Agility and Leadership Agility on project success, future research should also seek to empirically validate these findings in different industries and geographical contexts. Investigating Human Capital Agility, Leadership Agility, and their impact on project success in sectors such as manufacturing, healthcare, and information technology could provide deeper insights into the broader applicability of the framework. Additionally, cross-country comparisons would enhance the generalizability of the findings by identifying potential variations in how these factors influence project outcomes across different economic, cultural, and regulatory environments. Longitudinal data-based quantitative research can further enrich the understanding of the dynamic relationship between Human Capital Agility, Leadership Agility, and Project Success. Moreover, future studies should explore the development of a measurement tool for practical application in companies within the construction sector, ensuring that the proposed framework remains relevant and adaptable across various settings. Validating the framework in diverse contexts would not only strengthen its robustness but also offer practical recommendations tailored to different industries and regions.

6. Conclusions

This study highlights the importance of human capital agility and leadership agility in responding to the challenges of the Indonesian construction sector in the VUCA and disruption era. The results of this study show that the success of a construction project is no longer measured only through three traditional dimensions (time, cost, and quality), but can also be determined/assessed through the achievement of sustainability, environmental performance, and profitability components.

Theoretically, this study extends the literature by exploring and developing the concepts of human capital agility, leadership agility, and project success in the context of the construction sector. Key components such as flexibility, responsiveness, proactivity, and

adaptability support agility. From a practical perspective, this study provides strategic guidance for stakeholders in improving the competitiveness of the construction sector by optimizing human capital and leadership. Based on this framework, the Indonesian construction sector is expected to better navigate the global challenges of the VUCA era and disruption, increase operational efficiency, and promote long-term sustainability, providing valuable insights for similar emerging economies facing similar disruptions.

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Institutional Review Board Statement: The study was conducted in accordance with the principles of the Declaration of Helsinki (1975), as revised in 2013 and complies with national and institutional ethical guidelines.

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Appendix A

Appendix A.1

FGD and FDM Interview Protocol

Objectives of FGD: This FGD and FDM aims to explore four main elements: leadership agility, human capital agility, and project success can contribute significantly to the successful implementation of construction projects in Indonesia.

Strategic Role of FGD and FDM Participants:

1. Discuss and share practical insights based on field experience, on the four questions, and three variables that will be submitted.
2. Contribute relevant input to research.
3. Be an integral part of research and contribute directly to the development of science in the field of construction project management.

Moderator: Galih Cipta S

Basic Rules of FGD:

1. The moderator will not participate in the discussion, but will help keep the discussion flowing, manage time, and ensure all necessary topics are covered.
2. FGD participants can raise their hands first before giving their opinions. After being invited, you will be given time to express your views freely, honestly, and openly.
3. There is no right or wrong answer in this discussion. The most important thing is to convey what really happens in the field and your experience in construction projects.

4. Every view of you is valuable and all opinions are treated equally without any being considered superior to others. All perspectives will enrich our understanding of the topic being discussed.
5. The moderator can dig further or confirm statements made by participants to clarify or deepen the discussion.
6. The moderator can also ask for views from participants to gain a broader perspective.

Appendix A.2

FGD and FDM Questions List

FGD Questions List:

Session I Questions: Current conditions of the construction sector in Indonesia

1. Do you feel that there is a condition of uncertainty, rapid change (VUCA), technological disruption, automation advancement, and socio-economic changes in the construction sector today? (Yes/No/Uncertain. Explain:).
2. In your opinion, what impacts are caused by uncertain conditions and rapid changes in projects that you are or have previously run? (can explain how big the impact is) (examples: cost overrun, time overrun, etc.).

Session II Questions: Initiatives in dealing with project constraints

3. What steps have you and your company taken to overcome obstacles or failures in achieving targets on projects that are currently or have been carried out? (example: short-, medium-, and long-term strategies).

Session III Questions: The final section.

4. In your opinion, are there any other important points that are relevant to human capital agility, leadership agility, knowledge management and project success in the construction sector that we have not discussed that you would like to convey?

FDM Questions Form:

We invite you to participate in this survey by rating each component that influences project success, human capital agility, and leadership agility in a project management environment. You are expected to rate each of these components according to their level of importance in driving team agility and overall project success, using a scale of 1–7. Where: 1 represents “Very Unimportant”, 2 represents “Unimportant”, 3 represents “Slightly Unimportant”, 4 represents “Neutral”, 5 represents “Slightly Important”, 6 represents “Important”, and 7 represents “Very Important”.

Table A1. Components of the project success.

Components	Description	1	2	3	4	5	6	7
Time	A project is successful if it can be completed according to the planned schedule, without significant delays and according to the set time target.							
Cost	Project success is measured by its ability to be completed within the set budget, by optimizing the use of resources to avoid cost overruns.							
Quality	A project is considered successful if the final result meets or exceeds the set quality standards, both in terms of technical specifications and end-user satisfaction.							
Sustainability	A project is considered successful if it considers the long-term impact on the environment and contributions to overall social, economic, and ecological sustainability.							
Stakeholder satisfaction	A project's success depends on the level of satisfaction of stakeholders, including clients, stakeholders, and other parties involved or affected by the project.							
Safety	A project is considered successful if it is implemented by minimizing the risk of accidents and maintaining the health and safety of all workers involved during the project implementation.							
Defects	A project's success is measured by the minimum level of defects or deficiencies in the final result, which indicates that the project was carried out with good quality control.							
Profitability	A project is considered successful if it can generate benefits for related parties, especially the company carrying out the project, both in terms of finance and other added value.							
Customer satisfaction	Customer satisfaction is very important in determining the success of a project, where the project results are in accordance with the expectations, needs, and desires of customers or end users.							
Workplace organization	Good work organization, including team management and structured workflows, are indicators of success in facilitating efficiency and productivity during the project.							
Health	A project is considered successful if it not only pays attention to technical results, but also the physical and mental health of workers, and maintains the welfare of the workforce involved in the project.							
Environmental performance	Good environmental performance is a benchmark for success, where the project does not damage the surrounding environment and instead provides a positive, sustainable impact on the ecosystem.							
Participant satisfaction	Project success is also seen from the level of satisfaction of participants, both workers and collaborators, who feel positively involved and treated well during the project.							
Customer expectations	A successful project is one that is able to meet or even exceed customer expectations, providing results that are in accordance with expectations or better than initial expectations.							

Table A2. Components of the human capital agility.

Components	Description	1	2	3	4	5	6	7
Talent	An individual's unique innate abilities, which can be developed through training and experience. This includes natural potential that allows an individual to excel in a particular role.							
Education	An individual's formal background, which includes academic degrees and certifications. Education provides the theoretical and knowledge base that aids in the development of technical and professional skills.							
Experience	An individual's direct involvement in a particular job or situation over a period of time. This includes practical knowledge gained through practice and repetition in a work environment.							
Knowledge	An individual's understanding or insight into a field or topic. Knowledge can be theoretical or practical and plays a significant role in decision-making.							
Skill	An ability learned and developed through practice to perform a specific task with efficiency and effectiveness. Skills can be technical or non-technical, such as communication or leadership.							
Attitudes	An individual's outlook or mental disposition toward a job, team, or work environment. A positive attitude usually helps create a conducive and productive work environment.							
Creativity	The ability to generate new and innovative ideas and find unconventional solutions to problems. This is especially important in organizations that strive to innovate and adapt to change.							
Leadership	An individual's ability to motivate, direct, and guide others in achieving common goals. Leadership involves decision-making, strategic vision and managing teams.							
Job tenure	The length of time an individual has been in a role or organization. The longer a person has been in a position or company, the more likely they are to have a deeper understanding and insight into the job or organization, which increases their productivity and contribution.							
Age	Age is often associated with experience, maturity and emotional stability; however, it can also affect adaptability to new technologies or more modern working methods.							
Informal on-the-job training	Learning that occurs in the workplace, outside of formal training structures. Employees learn through direct experience, observation and interaction with colleagues, which can significantly improve their practical skills.							
Predispositions	Innate tendencies refer to the natural traits or personality traits of an individual that influence how they work and interact in a professional environment. This includes characteristics such as ambition, initiative or the ability to adapt to change.							
Health	An individual's health affects their ability to work productively and consistently. Good physical and mental health allows individuals to focus, work longer hours and reduces the likelihood of absenteeism or illness.							
Adaptability/ Adaptive	Readiness to adapt quickly to changing circumstances or unexpected demands in the work environment.							

Table A2. *Cont.*

Components	Description	1	2	3	4	5	6	7
Flexibility	The ability to adapt or change approaches, strategies, or actions to meet new needs or changing situations.							
Responsiveness	The ability to adapt quickly to changes in the environment or marketplace, including making decisions and acting in a timely manner.							
Proactivity	The ability to anticipate or control situations, rather than simply waiting to react to events as they occur.							
Resilience	The ability to recover or bounce back from stress, adversity, or challenges.							
Generative	The ability to generate new ideas, solutions, or innovations that can be used to address challenges in the workplace or on projects.							
Effectiveness	The ability to achieve desired goals efficiently using available resources.							

Table A3. Components of the leadership agility.

Components	Description	1	2	3	4	5	6	7
Critical thinker	Ability to objectively analyze and evaluate information, identify logical relationships, and effectively solve complex problems.							
Emotionally intelligent	The ability to recognize, understand, and manage emotions in self and others to build stronger relationships and make informed decisions.							
Anxiety-managing	Anxiety management and control skills to maintain focus and performance during stressful or uncertain situations.							
Adaptable	The ability to adapt to new circumstances, roles, or environments quickly and efficiently, remains effective despite change.							
Contextually intelligent	The ability to read and interpret situational variables and apply appropriate strategies based on context and complexity.							
Resilient	The ability to bounce back from setbacks, challenges, or adversity while remaining focused on goals and objectives.							
Innovative	The ability to generate creative ideas and implement new solutions to overcome obstacles or exploit new opportunities.							
Speedy	The ability to respond and act quickly to changing circumstances, maintaining momentum to achieve timely results.							
Flexible	The ability to change approaches, methods, or strategies as needed to accommodate evolving demands or circumstances.							
Sensitive	The ability to sense and respond appropriately to the needs, emotions, and concerns of others within the organization.							
Creative	The ability to generate original and unconventional ideas or solutions to solve problems or improve processes.							
Sensing	The ability to detect subtle signals or trends within an organization or market and respond proactively to emerging opportunities or threats.							
Adoptive	The capacity to embrace and implement new practices, technologies or ideas to improve performance or meet new challenges.							

Table A3. Cont.

Components	Description	1	2	3	4	5	6	7
Responsive	The ability to react quickly and appropriately to external stimuli or feedback, ensuring timely and effective decision-making.							
Effective In Recognizing Problems	The ability to identify potential problems or challenges early and accurately, enabling timely intervention and resolution.							
Decisive	The ability to make clear and confident decisions quickly, even under pressure or in uncertain situations.							
Collaborative	The capacity to work well with others, fostering cooperation, and collaboration to achieve common goals.							
Change effectively	The ability to implement change within the organization smoothly, ensuring minimal disruption while achieving desired outcomes.							
Active learner	A commitment to continuous learning and self-improvement by seeking new knowledge and experiences to enhance leadership capabilities.							
Being a role model	Demonstrates behaviors, values and practices that are exemplary for others in the organization.							
Having a future-oriented mindset	The ability to think strategically about long-term goals, anticipate future trends and prepare the organization for upcoming challenges or opportunities.							
Anticipate change	The ability to forecast and prepare for potential changes in the environment, enabling a proactive rather than reactive strategy.							
Critical thinker	The ability to objectively analyze and evaluate information, identify logical relationships, and effectively solve complex problems.							

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