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CONCEPTUALISING ENGLISH COMMUNICATION READINESS IN ENGINEERING EDUCATION: A MULTIDIMENSIONAL FRAMEWORK FOR THE ENGLISH COMMUNICATION READINESS INDEX (ECRI)

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ABSTRACT
The increasing emphasis on graduate employability and professional competence has positioned English communication as a fundamental attribute of engineering education. Contemporary engineers are expected to communicate effectively in academic, technical, and professional contexts, requiring competencies that extend beyond conventional language proficiency. However, existing communication assessment approaches primarily focus on discrete language skills and fail to provide a comprehensive understanding of students' overall communication readiness. Addressing this gap, the present study proposes the English Communication Readiness Index (ECRI) as a multidimensional conceptual framework for understanding and assessing communication readiness among undergraduate engineering students. The framework is developed through an extensive synthesis of contemporary literature on Communicative Competence Theory, English for Specific Purposes (ESP), Competency-Based Education (CBE), Outcome-Based Education (OBE), and graduate employability. It conceptualises English communication readiness as an integrated construct comprising seven interrelated dimensions: Academic Communication, Professional Speaking, Technical Writing, Listening Competence, Presentation Skills, Interpersonal Communication, and Communication Confidence. Collectively, these dimensions provide a holistic perspective on the communication competencies required for academic achievement and professional engineering practice. The proposed framework contributes to engineering education by offering a theoretically grounded foundation for curriculum design, communication assessment, competency-based instruction, and educational policy. Furthermore, it establishes a research agenda for future empirical validation and cross-disciplinary application, thereby supporting the development of communication-ready engineering graduates capable of succeeding in increasingly global, collaborative, and technology-driven professional environments.

Keywords: English Communication Readiness Index (ECRI); Engineering Education; Communication Readiness; Conceptual Framework; Graduate Employability; Competency-Based Education.

1. INTRODUCTION
The twenty-first century has transformed engineering education through rapid technological advancement, digital innovation, globalization, and interdisciplinary collaboration. Engineers today are expected not only to possess technical expertise but also to communicate effectively with colleagues, clients, policymakers, and other stakeholders across diverse professional and cultural settings. Consequently, communication has evolved from a supplementary language skill into a fundamental professional competency that directly influences employability, workplace performance, innovation, leadership, and lifelong learning.
International accreditation agencies and professional engineering bodies consistently recognise communication as a core graduate attribute. Modern engineers are required to prepare technical reports, deliver presentations, participate in multidisciplinary projects, collaborate through digital platforms, and explain complex engineering concepts to both specialist and non-specialist audiences. Therefore, communication extends far beyond the transmission of information; it involves active listening, critical thinking, collaboration, negotiation, and contextual adaptation. George Bernard Shaw aptly remarked

that “The single biggest problem in communication is the illusion that it has taken place.” This observation highlights the importance of ensuring that technical knowledge is communicated accurately, clearly, and meaningfully.

The emergence of the Fourth Industrial Revolution has further reinforced the significance of communication in engineering practice. Technologies such as artificial intelligence, robotics, cloud computing, big data analytics, the Internet of Things, and cybersecurity have created globally connected workplaces where engineers collaborate across geographical and disciplinary boundaries. Employers increasingly seek graduates who combine technical competence with communication skills, teamwork, adaptability, and professional confidence. As a result, communication has become a defining characteristic of successful engineering professionals.

English occupies a central position within this evolving landscape because it serves as the global language of science, technology, engineering, and research. Engineering students encounter English throughout their academic and professional journeys through textbooks, technical manuals, research articles, software documentation, laboratory reports, conferences, and industrial communication. Proficiency in English enables graduates to participate effectively in international collaborations, publish research, engage with multinational organisations, and access global knowledge resources. Consequently, English communication competence has become an indispensable element of graduate employability and professional mobility.

Recognising these developments, higher education institutions have increasingly integrated communication-oriented learning into engineering curricula. Traditional classroom instruction is now complemented by project-based learning, collaborative assignments, technical presentations, industrial internships, case studies, and experiential learning activities that encourage students to apply communication skills in authentic contexts. These developments reflect a broader transition from content-based instruction towards competency-based education, where graduates are expected to demonstrate practical abilities rather than merely theoretical knowledge.

Despite these curricular improvements, many engineering graduates continue to experience difficulties in professional communication. While students often possess satisfactory grammatical knowledge and technical understanding, they may struggle with technical writing, oral presentations, interpersonal interaction, collaborative discussions, and workplace communication. These challenges indicate that communication competence cannot be measured solely through language proficiency. Effective communication requires the integration of linguistic knowledge, professional behaviour, interpersonal skills, confidence, and contextual awareness.

This changing educational landscape has encouraged researchers to reconsider how communication should be conceptualised within engineering education. Contemporary scholarship increasingly views communication as a multidimensional graduate capability rather than a collection of isolated language skills. Such a perspective aligns with current educational priorities that emphasise transferable skills, graduate attributes, employability, and lifelong learning. Employers similarly expect engineering graduates to demonstrate communication abilities alongside technical excellence.

The concept of communication readiness has emerged from this broader understanding. Unlike traditional approaches that focus primarily on grammar or language proficiency, communication readiness refers to an individual's preparedness to communicate effectively across academic, professional, interpersonal, and organisational contexts. It represents the ability to apply communication knowledge confidently and appropriately while adapting to diverse audiences, situations, and workplace demands. Therefore, communication readiness encompasses not only knowledge and skills but also attitudes, behaviour, confidence, and professional judgement.

Several theoretical perspectives support this multidimensional understanding. Communicative Competence Theory argues that successful communication involves linguistic, sociocultural, discourse, and strategic competencies rather than grammatical knowledge alone. English for Specific Purposes (ESP), particularly English for Engineering Purposes (EEP), emphasises that communication instruction should reflect authentic engineering contexts, including technical reports, presentations, meetings, research publications, and industrial interactions. Similarly, Competency-Based Education (CBE) and Outcome-Based Education (OBE) focus on demonstrable learning outcomes, encouraging

authentic assessments that evaluate communication through presentations, teamwork, documentation, reflective practice, and workplace simulations instead of traditional examinations alone.
Graduate employability further reinforces the importance of communication readiness. Employers consistently identify communication as one of the most influential factors affecting recruitment, workplace effectiveness, leadership, and career progression. Although engineering graduates generally demonstrate strong technical competence, employers frequently report shortcomings in presentation skills, professional writing, interpersonal communication, teamwork, and workplace confidence. These observations indicate that employability depends upon a balanced integration of technical expertise and communication competence.
The rapid digitalisation of engineering workplaces has expanded communication requirements even further. Engineers now collaborate through virtual meetings, cloud-based documentation systems, online project management platforms, and international professional networks. Consequently, communication competence must include digital literacy, virtual collaboration, and intercultural communication alongside traditional face-to-face interaction. Existing assessment approaches, however, have not always reflected these emerging professional realities.

Despite growing research interest, communication assessment within engineering education remains fragmented. Most studies examine speaking, writing, listening, presentation skills, or interpersonal communication independently without considering how these competencies collectively contribute to professional readiness. Traditional language assessments continue to emphasise grammar, vocabulary, reading comprehension, and writing accuracy while paying comparatively less attention to professional interaction, communication confidence, collaborative problem-solving, and workplace adaptability. Furthermore, communication-related concepts such as communication competence, employability skills, language proficiency, professional communication, and graduate attributes are often used interchangeably, resulting in conceptual inconsistency.

Another limitation is that many existing communication models have been developed for general higher education rather than engineering education. Engineering communication possesses distinctive characteristics because it combines technical accuracy with problem-solving, project management, innovation, documentation, and stakeholder engagement. Engineers must communicate specialised knowledge accurately while making it understandable to audiences with different levels of technical expertise. Consequently, engineering education requires a context-specific framework that reflects the unique communication demands of the profession.

To address these conceptual gaps, the present study proposes the English Communication Readiness Index (ECRI) as a multidimensional conceptual framework for undergraduate engineering education. Rather than viewing communication as a collection of isolated language skills, the ECRI conceptualises communication readiness as an integrated graduate capability comprising seven interconnected dimensions: Academic Communication, Professional Speaking, Technical Writing, Listening Competence, Presentation Skills, Interpersonal Communication, and Communication Confidence. Together, these dimensions provide a comprehensive understanding of the competencies required for academic success, workplace effectiveness, and professional growth.

The proposed framework contributes to engineering education by offering a coherent theoretical foundation for curriculum development, competency-based assessment, graduate attribute evaluation, and communication training. It encourages educators to integrate communication across engineering programmes instead of limiting it to language courses. Furthermore, it provides researchers with a conceptual basis for developing valid assessment instruments, conducting empirical validation, comparing communication readiness across engineering disciplines, and evaluating educational interventions.
The objectives of this conceptual paper are fourfold: (i) to examine the evolving role of English communication in engineering education; (ii) to identify the conceptual limitations of existing communication assessment approaches; (iii) to propose the English Communication Readiness Index (ECRI) as a multidimensional framework for understanding communication readiness among

engineering students; and (iv) to discuss its implications for curriculum design, assessment, graduate employability, and future research.

As engineering education continues to evolve in response to technological innovation and globalisation, communication can no longer be regarded as a peripheral graduate skill. Instead, it must be recognised as a strategic professional capability that underpins collaboration, innovation, leadership, and lifelong learning. By conceptualising English communication readiness as a multidimensional construct, the proposed ECRI provides a comprehensive theoretical framework that strengthens engineering education and supports the preparation of graduates who are technically proficient, professionally competent, and capable of communicating effectively in increasingly complex global engineering environments.

2. OBJECTIVES OF THE STUDY

1. To examine the significance of English communication in preparing engineering students for academic and professional success.
2. To explore the key dimensions that contribute to English communication readiness among undergraduate engineering students.
3. To develop a multidimensional conceptual framework for the English Communication Readiness Index (ECRI).
4. To establish a theoretical foundation for assessing English communication readiness in engineering education.
5. To provide a conceptual basis for enhancing communication-focused curriculum design, assessment practices, and future research in engineering education.

3. LITERATURE REVIEW

The increasing emphasis on graduate employability and global engineering practice has positioned English communication as a fundamental competency in engineering education. Contemporary engineers are expected to communicate technical information effectively, collaborate with multidisciplinary teams, prepare professional documentation, and engage confidently with stakeholders across diverse cultural and organisational contexts. Consequently, communication has evolved beyond a supporting language skill into a strategic professional capability that significantly influences academic achievement, workplace performance, innovation, and leadership. Recent scholarship has therefore shifted its attention from measuring isolated communication skills to understanding communication as a multidimensional construct closely associated with professional readiness and graduate competence.

One of the earliest and most influential theoretical foundations for communication research is Communicative Competence Theory, proposed by Hymes (1972) and later expanded by Canale and Swain (1980). This theory argues that successful communication involves much more than grammatical accuracy. Effective communicators require linguistic competence, sociolinguistic competence, discourse competence, and strategic competence to communicate appropriately in different situations. Within engineering education, this perspective suggests that students should not merely possess knowledge of English grammar but should also demonstrate the ability to communicate technical ideas clearly, adapt language to professional contexts, and interact confidently with diverse audiences. Contemporary studies continue to support this multidimensional understanding, emphasising that engineering communication must integrate technical accuracy with interpersonal effectiveness and contextual adaptability.

The growing importance of English for Specific Purposes (ESP), particularly English for Engineering Purposes (EEP), has further strengthened communication research in engineering education. ESP scholars argue that language instruction should reflect authentic professional contexts rather than focusing exclusively on general English proficiency. Engineering students require specialised communication competencies, including technical report writing, laboratory documentation, research publication, project presentations, proposal writing, professional correspondence, and workplace interaction. Recent research indicates that contextualised communication instruction significantly

enhances students' confidence, professional identity, and workplace preparedness. Consequently, engineering communication is increasingly viewed as profession-specific rather than language-centred.

Another important development is the adoption of Competency-Based Education (CBE) and Outcome-Based Education (OBE) across engineering institutions worldwide. These educational approaches emphasise demonstrable learning outcomes rather than the acquisition of theoretical knowledge alone. Communication has become one of the principal graduate attributes identified by accreditation agencies because employers consistently expect graduates to demonstrate effective speaking, writing, listening, teamwork, and professional interaction. Recent studies show that competency-based assessment methods, including presentations, project reports, peer collaboration, reflective learning, and industrial internships, provide more authentic measures of communication competence than traditional language examinations. These findings support the argument that communication should be assessed through performance in realistic professional situations.

Graduate employability has emerged as another dominant theme within the literature. Numerous international studies consistently identify communication as one of the most desirable employability skills alongside technical expertise, critical thinking, problem-solving, teamwork, and adaptability. Employers frequently report that while engineering graduates possess strong technical knowledge, many experience difficulties in oral communication, professional writing, interpersonal interaction, presentation delivery, and workplace confidence. These communication deficiencies often influence recruitment decisions, workplace integration, leadership opportunities, and career advancement. Consequently, higher education institutions have increasingly integrated communication development into engineering curricula to bridge the gap between academic preparation and industry expectations.

The rapid digitalisation of engineering workplaces has further transformed professional communication. Engineers now collaborate through virtual meetings, cloud-based documentation systems, online project management platforms, collaborative software, and international digital networks. Communication therefore extends beyond face-to-face interaction to include digital communication, virtual teamwork, online presentations, and intercultural collaboration. Recent research suggests that digital communication competence has become an essential component of professional readiness because engineers frequently work within geographically distributed teams. These developments reinforce the need to broaden communication education beyond traditional language instruction and incorporate digital literacy, technological adaptability, and cross-cultural communication.

Although communication has received considerable scholarly attention, existing research continues to demonstrate several conceptual limitations. A significant proportion of studies investigate communication competencies independently by focusing on speaking skills, technical writing, listening ability, presentation competence, or interpersonal communication in isolation. While these investigations provide valuable insights into individual communication domains, they seldom explain how these competencies collectively contribute to overall professional readiness. This fragmented approach limits the development of comprehensive communication assessment models capable of representing the complexity of engineering communication.

Another limitation concerns the dominance of language-oriented assessment methods. Traditional communication evaluation frequently emphasises grammar, vocabulary, reading comprehension, and writing accuracy while paying comparatively less attention to professional interaction, communication confidence, teamwork, adaptability, and workplace communication. Although linguistic proficiency remains an important foundation, recent scholarship argues that successful engineering communication depends equally upon behavioural, interpersonal, cognitive, and contextual competencies. Accordingly, communication should be understood as an integrated professional capability rather than merely a language skill.

Recent educational research has therefore introduced the concept of communication readiness, which extends beyond conventional communication competence. Communication readiness refers to an individual's preparedness to communicate effectively across academic, professional, interpersonal, and organisational settings. It reflects the ability to integrate knowledge, skills, confidence, behaviour, and contextual judgement while responding appropriately to diverse communication situations. This perspective aligns with broader developments in higher education that emphasise graduate capabilities,

transferable skills, lifelong learning, and professional adaptability. Rather than assessing isolated language performance, communication readiness evaluates the extent to which graduates are prepared to apply communication competencies within authentic professional environments.

Despite growing recognition of communication readiness, relatively few studies have attempted to develop comprehensive theoretical frameworks specifically designed for engineering education. Existing models frequently use concepts such as communication competence, soft skills, graduate attributes, employability skills, professional communication, and language proficiency interchangeably, resulting in conceptual ambiguity and inconsistent assessment practices. Furthermore, many communication frameworks have been developed for general higher education populations without considering the unique communication requirements associated with engineering practice. Engineers must simultaneously demonstrate technical precision, collaborative problem-solving, documentation skills, client interaction, leadership, and interdisciplinary communication, making engineering communication substantially different from communication in many other academic disciplines.

The literature therefore highlights an important research gap. Although substantial progress has been made in strengthening communication instruction through ESP, competency-based education, outcome-based learning, and employability-focused curricula, there remains no widely accepted multidimensional framework capable of conceptualising English communication readiness specifically for undergraduate engineering students. Existing assessment approaches continue to measure communication as separate competencies rather than as an integrated graduate capability. Consequently, educators lack a coherent theoretical model that explains how multiple communication dimensions interact to influence students' readiness for academic success and professional practice.

The present study addresses this gap by proposing the English Communication Readiness Index (ECRI) as a multidimensional conceptual framework for engineering education. The ECRI synthesises insights from communication studies, English for Specific Purposes, competency-based education, outcome-based education, graduate employability research, and engineering education to conceptualise communication readiness as an integrated construct. Unlike conventional assessment models, the framework comprises seven interconnected dimensions—Academic Communication, Professional Speaking, Technical Writing, Listening Competence, Presentation Skills, Interpersonal Communication, and Communication Confidence. These dimensions collectively represent the competencies required for effective communication in academic, industrial, and global engineering environments.

Overall, the literature demonstrates that communication has become a strategic graduate capability essential for engineering education in the twenty-first century. However, the fragmented nature of existing communication assessment highlights the need for a comprehensive conceptual framework that integrates linguistic, professional, interpersonal, and behavioural competencies. By addressing this gap, the proposed ECRI provides a stronger theoretical foundation for curriculum development, communication assessment, graduate employability, and future empirical research. It also offers a holistic perspective that aligns communication education with the evolving expectations of engineering practice, thereby contributing to the advancement of communication research within engineering education.

4. METHODOLOGY

The present study adopts a conceptual research methodology to develop the English Communication Readiness Index (ECRI) as a multidimensional framework for understanding English communication readiness among undergraduate engineering students. Unlike empirical investigations that rely on primary data collected through surveys, interviews, or experiments, conceptual research seeks to analyse existing theoretical knowledge, synthesise scholarly perspectives, and construct a coherent framework capable of addressing an identified research gap. The primary objective of this study is therefore not to validate a measurement instrument statistically but to establish a strong theoretical foundation that explains the dimensions constituting English communication readiness within engineering education.

The study is grounded in an extensive review and synthesis of contemporary literature related to engineering education, English language teaching, communication competence, graduate employability, competency-based education, outcome-based education, and English for Specific Purposes (ESP). Scholarly publications from peer-reviewed journals, conference proceedings, academic books, accreditation reports, and international educational frameworks were systematically examined to identify recurring themes associated with communication competence in engineering contexts. Preference was given to recent publications published during the last decade to ensure that the proposed framework reflects the evolving communication requirements of contemporary engineering education and the rapidly changing global workplace. Classical theories that have significantly influenced communication research, such as Communicative Competence Theory, were also included to provide the necessary theoretical foundation.

The methodology followed a structured conceptual development process consisting of four sequential stages. The first stage involved identifying the research problem through a critical examination of existing literature. Previous studies consistently highlighted the growing importance of communication skills in engineering education while simultaneously revealing the fragmented nature of existing communication assessment approaches. Most studies focused on individual competencies such as speaking, writing, listening, or presentation skills without considering communication readiness as an integrated construct. This fragmentation created a significant theoretical gap, indicating the need for a comprehensive conceptual framework capable of explaining the multidimensional nature of communication readiness among engineering students.

The second stage involved a comprehensive thematic review of relevant literature to identify the principal dimensions associated with effective English communication in engineering education. During this process, studies examining engineering communication, workplace communication, professional communication, graduate employability, communication competence, English for Engineering Purposes, and higher education graduate attributes were analysed comparatively. Common concepts, recurring competencies, and frequently discussed communication behaviours were identified and organised into thematic categories. Rather than adopting dimensions from a single theoretical model, the present study synthesised complementary perspectives from multiple educational theories to ensure broader conceptual coverage and greater applicability within engineering education.

The third stage focused on the conceptual integration of these themes into a unified framework. Similar communication competencies identified across the literature were compared, refined, and consolidated to eliminate conceptual overlap while preserving their distinct educational significance. Particular attention was given to ensuring that each proposed dimension represented an independent aspect of communication readiness while simultaneously contributing to the overall construct. Through this iterative process, seven interrelated dimensions were identified as representing the core components of English communication readiness among undergraduate engineering students: Academic Communication, Professional Speaking, Technical Writing, Listening Competence, Presentation Skills, Interpersonal Communication, and Communication Confidence. These dimensions collectively reflect the communication competencies required for successful participation in academic learning environments, professional workplaces, and global engineering practice.

The final stage involved developing the English Communication Readiness Index (ECRI) as a multidimensional conceptual framework. The proposed framework illustrates how the seven dimensions interact to represent communication readiness as a holistic graduate capability rather than a collection of isolated language skills. Instead of assuming that communication competence depends exclusively on linguistic proficiency, the framework recognises that effective communication emerges through the interaction of cognitive, behavioural, interpersonal, professional, and contextual competencies. Accordingly, the ECRI provides a theoretical representation of communication readiness that may serve as a foundation for curriculum development, educational assessment, and future empirical investigation.

The conceptual framework is supported by several complementary theoretical perspectives. Communicative Competence Theory provides the linguistic foundation by emphasising that successful

communication requires grammatical, sociolinguistic, discourse, and strategic competencies. English for Specific Purposes (ESP) contributes the professional dimension by highlighting the importance of context-specific communication relevant to engineering practice. Competency-Based Education (CBE) and Outcome-Based Education (OBE) reinforce the framework by focusing on demonstrable graduate competencies rather than theoretical knowledge alone. Finally, Graduate Employability Theory emphasises communication as a critical professional capability influencing recruitment, workplace performance, collaboration, leadership, and career progression. The integration of these theories strengthens the conceptual validity of the proposed framework and ensures that it reflects both educational principles and professional expectations.

The proposed ECRI framework conceptualises communication readiness through seven interconnected dimensions. Academic Communication refers to students' ability to communicate effectively within academic environments through classroom discussions, collaborative learning, report preparation, and scholarly interaction. Professional Speaking represents the ability to express technical ideas clearly during meetings, interviews, workplace discussions, and professional interactions. Technical Writing reflects competence in preparing reports, proposals, documentation, laboratory records, and research papers using appropriate technical language and professional conventions. Listening Competence refers to the ability to understand lectures, workplace instructions, technical discussions, and collaborative conversations accurately. Presentation Skills represent the capacity to organise and deliver technical information confidently to diverse audiences using effective verbal and non-verbal communication. Interpersonal Communication focuses on teamwork, collaboration, relationship building, conflict management, and professional interaction. Communication Confidence reflects the willingness, self-efficacy, and professional assurance required to communicate effectively across different academic and workplace situations. Together, these dimensions provide a comprehensive representation of English communication readiness.

Since the present investigation is conceptual rather than empirical, no human participants were involved, and no primary data were collected. Consequently, procedures relating to sampling techniques, questionnaire development, statistical analysis, reliability testing, or ethical clearance applicable to empirical studies were not required. Instead, methodological rigour was achieved through systematic literature selection, careful thematic synthesis, theoretical integration, and logical conceptual development. Multiple scholarly sources representing different educational perspectives were reviewed to minimise conceptual bias and strengthen the comprehensiveness of the proposed framework.

The credibility of the conceptual framework was further enhanced through triangulation of educational theories. Rather than relying exclusively on a single theoretical perspective, the framework integrates concepts from communication studies, engineering education, English language teaching, higher education research, graduate employability, and competency-based learning. This interdisciplinary synthesis ensures that the proposed framework reflects the complex communication requirements of contemporary engineering education while remaining theoretically coherent. Such an approach also increases the potential applicability of the framework across different engineering disciplines and institutional contexts.

Although the present study does not include empirical validation, it establishes a strong theoretical platform for future research. The proposed framework may subsequently be operationalised through the development of a psychometrically validated assessment instrument capable of measuring English communication readiness among engineering students. Future investigations may employ exploratory and confirmatory factor analyses to examine the dimensional structure of the framework, assess construct validity, evaluate reliability, and test its applicability across different educational settings. Longitudinal studies may also investigate how communication readiness develops throughout engineering programmes and how it influences graduate employability, workplace performance, and professional success.

The methodology adopted in this study is particularly appropriate for conceptual research because it systematically integrates existing knowledge into a coherent theoretical framework capable of addressing an important gap in engineering education literature. By synthesising established educational theories with contemporary communication requirements, the study moves beyond fragmented

communication assessment approaches and proposes a holistic understanding of English communication readiness. The resulting English Communication Readiness Index (ECRI) therefore provides a theoretically grounded framework that can inform curriculum design, communication training, educational assessment, policy development, and future empirical research. As engineering education continues to respond to technological innovation, digital transformation, and global professional collaboration, such a multidimensional conceptual framework offers a valuable foundation for preparing graduates who are not only technically competent but also confident and effective communicators in increasingly complex engineering environments.

5. ANALYSIS AND DISCUSSION

The present study proposes the English Communication Readiness Index (ECRI) as a multidimensional conceptual framework to explain how various communication competencies collectively prepare undergraduate engineering students for academic achievement and professional practice. Since this is a conceptual study, the analysis is based on the critical interpretation and synthesis of existing theories and contemporary literature rather than on statistical analysis of empirical data. The discussion therefore focuses on examining the conceptual significance of each proposed dimension, explaining their interrelationships, and highlighting their implications for engineering education.

The review of the literature demonstrates that communication has become one of the most essential graduate competencies expected from engineering students. While technical knowledge continues to remain the foundation of engineering education, employers increasingly expect graduates to communicate technical information accurately, collaborate with multidisciplinary teams, prepare professional documentation, participate in decision-making, and interact confidently with clients and stakeholders. Consequently, communication is no longer viewed as an additional language skill but as a strategic professional capability that directly influences employability, workplace effectiveness, innovation, and leadership.

A major observation emerging from the literature is that most existing communication studies investigate communication competencies independently. Researchers have examined technical writing, oral communication, presentation skills, listening ability, interpersonal communication, and workplace interaction separately. Although these studies have substantially contributed to understanding individual communication competencies, they provide only a fragmented explanation of communication preparedness. Engineering graduates rarely use these competencies in isolation. Instead, they employ several communication skills simultaneously while solving engineering problems, managing projects, interacting with colleagues, and communicating with clients. This fragmentation therefore limits the development of comprehensive communication assessment models capable of representing the realities of professional engineering practice.

The proposed ECRI addresses this limitation by conceptualising English communication readiness as a holistic construct comprising seven interrelated dimensions. Rather than treating communication as a collection of unrelated skills, the framework recognises that effective communication emerges through the interaction of academic, professional, behavioural, interpersonal, and psychological competencies. Each dimension contributes independently to communication readiness while simultaneously strengthening the effectiveness of the remaining dimensions.

The first dimension, Academic Communication, forms the foundation of communication readiness because engineering students initially develop their communication abilities within academic environments. Classroom discussions, laboratory activities, project work, report preparation, seminars, collaborative assignments, and research activities require students to express ideas logically, interpret technical information accurately, and communicate effectively with peers and instructors. The literature consistently indicates that students who actively participate in academic communication demonstrate higher levels of conceptual understanding, collaborative learning, and professional preparedness. Therefore, academic communication represents the starting point from which broader professional communication competencies gradually develop.

The second dimension, Professional Speaking, reflects students' ability to communicate confidently in workplace situations. Contemporary engineering professionals frequently participate in meetings, technical discussions, interviews, client interactions, project reviews, and multidisciplinary

collaborations. Professional speaking therefore extends beyond grammatical correctness and includes clarity, confidence, persuasion, audience awareness, and professional etiquette. The literature suggests that graduates possessing strong oral communication skills adapt more successfully to industrial environments and demonstrate greater leadership potential. Consequently, professional speaking constitutes an essential component of communication readiness within engineering education.

Technical Writing, the third dimension, occupies a particularly significant position because documentation is an integral aspect of engineering practice. Engineers regularly prepare laboratory reports, feasibility studies, technical manuals, project proposals, research papers, maintenance records, and engineering specifications. These documents require precision, logical organisation, objectivity, and adherence to professional conventions. Previous studies consistently identify technical writing as one of the competencies most highly valued by employers. However, many engineering graduates continue to experience difficulties in organising technical information effectively despite possessing adequate technical knowledge. This observation supports the inclusion of technical writing as an independent dimension within the ECRI framework.

The fourth dimension, Listening Competence, is frequently overlooked in communication assessment despite its central role in professional interaction. Effective engineers must accurately understand lectures, workplace instructions, technical discussions, client requirements, and collaborative conversations before responding appropriately. Active listening also facilitates teamwork, conflict resolution, problem-solving, and informed decision-making. Peter Drucker rightly observed that "the most important thing in communication is hearing what isn't said," emphasising that communication begins with understanding rather than speaking. The literature similarly indicates that listening competence enhances collaborative learning and improves overall communication effectiveness. Accordingly, listening competence forms an indispensable element of communication readiness.

The fifth dimension, Presentation Skills, represents students' ability to organise and communicate technical information systematically before academic or professional audiences. Engineering graduates frequently deliver seminars, project demonstrations, conference presentations, design reviews, and industrial briefings. Effective presentations require not only subject knowledge but also organisation, visual communication, audience engagement, verbal fluency, and confident delivery. Research consistently demonstrates that presentation competence contributes significantly to employability because employers often evaluate graduates through interviews, technical presentations, and group discussions. Therefore, presentation skills represent both an academic and professional competency essential for career success.

The sixth dimension, Interpersonal Communication, reflects the collaborative nature of modern engineering practice. Engineering projects increasingly involve multidisciplinary teams consisting of professionals from different educational backgrounds, cultures, and organisations. Successful engineers therefore require effective interpersonal skills to establish professional relationships, resolve conflicts, negotiate solutions, provide constructive feedback, and work collaboratively towards shared objectives. The literature consistently associates interpersonal communication with teamwork effectiveness, organisational productivity, leadership development, and workplace satisfaction. Consequently, interpersonal communication extends communication readiness beyond language proficiency by emphasising social interaction and collaborative competence.

The final dimension, Communication Confidence, functions as the integrating element that enables students to apply their communication competencies effectively. Many engineering students possess adequate linguistic knowledge but hesitate to communicate because of anxiety, fear of criticism, limited self-confidence, or lack of professional exposure. Recent educational research increasingly recognises confidence as a significant determinant of communication performance because confidence influences participation, presentation quality, leadership behaviour, and workplace interaction. Communication confidence therefore transforms theoretical knowledge into practical performance by encouraging students to communicate actively in diverse academic and professional situations.

An important contribution of the proposed framework lies in recognising the interdependence of these seven dimensions. None of the dimensions functions independently within authentic engineering environments. For example, an engineer delivering a project presentation simultaneously relies on technical writing to prepare content, listening competence to respond to questions, interpersonal communication to engage the audience, professional speaking for effective delivery, academic communication for conceptual clarity, and communication confidence to present persuasively. Similarly, workplace meetings require participants to integrate listening, speaking, interpersonal interaction, and technical knowledge rather than relying on a single communication competency. This integrated perspective distinguishes the ECRI from conventional communication models that assess individual skills separately.

The analysis further indicates that the proposed framework aligns closely with contemporary educational philosophies, particularly Competency-Based Education (CBE) and Outcome-Based Education (OBE). Both approaches emphasise demonstrable graduate competencies rather than theoretical knowledge alone. Communication readiness, as conceptualised in the ECRI, represents an observable graduate capability that can be developed progressively through classroom instruction, project-based learning, internships, presentations, collaborative assignments, industrial training, and authentic assessment. Consequently, the framework provides educators with a structured basis for embedding communication across engineering curricula instead of confining it to English language courses.

The ECRI also reflects the objectives of English for Specific Purposes (ESP) by recognising that engineering communication differs substantially from general English communication. Engineering graduates communicate within highly specialised professional contexts requiring technical vocabulary, discipline-specific discourse, scientific precision, documentation skills, and workplace interaction. The framework therefore positions English communication within authentic engineering environments rather than treating language learning as an isolated academic subject. This contextual orientation strengthens the professional relevance of communication education and better prepares graduates for industry expectations.

Another important finding emerging from the conceptual analysis concerns graduate employability. Numerous employer surveys consistently identify communication as one of the most influential employability attributes. Organisations seek graduates capable of presenting technical ideas clearly, collaborating effectively, communicating professionally, and adapting confidently to changing workplace environments. Although engineering institutions have strengthened technical education considerably, communication deficiencies continue to influence recruitment outcomes and workplace performance. The ECRI addresses this concern by integrating communication competencies most frequently associated with professional success, thereby providing a comprehensive conceptual foundation for employability-oriented curriculum development.

The framework also responds to the growing digitalisation of engineering workplaces. Modern engineers increasingly communicate through virtual meetings, collaborative software, cloud-based documentation, digital presentations, and international online networks. Consequently, communication readiness extends beyond face-to-face interaction to include adaptability across multiple communication platforms. While digital communication is embedded throughout the proposed dimensions rather than treated separately, the framework acknowledges that future communication education must prepare students for technology-mediated professional environments characterised by global collaboration and intercultural interaction.

From an institutional perspective, the ECRI provides several educational implications. Curriculum designers may utilise the framework to integrate communication systematically across engineering programmes. Faculty members may incorporate communication-based learning activities into technical subjects through seminars, design presentations, collaborative projects, laboratory documentation, reflective journals, and industrial case studies. Assessment practices may similarly move beyond traditional language examinations towards authentic performance-based evaluation that reflects professional communication requirements. Such curriculum integration ensures that communication

develops progressively throughout engineering education rather than being restricted to introductory language courses.
The framework also has important implications for quality assurance and accreditation. Engineering accreditation agencies increasingly evaluate graduate attributes related to communication, teamwork, ethics, lifelong learning, and professional competence. The multidimensional structure of the ECRI provides institutions with a conceptual basis for aligning communication education with these graduate outcomes. Furthermore, the framework supports continuous curriculum improvement by identifying specific communication dimensions requiring educational attention.

Although the present study is conceptual, it establishes a strong theoretical platform for future empirical investigation. Researchers may develop psychometrically validated measurement instruments based on the seven dimensions of the ECRI and examine their reliability and validity across different engineering disciplines and educational contexts. Longitudinal investigations may evaluate communication development throughout engineering programmes, while comparative studies may examine communication readiness among students from different institutions or countries. Structural equation modelling and factor analysis may further explore the relationships among the proposed dimensions and validate the multidimensional nature of communication readiness.
The originality of this study lies in shifting scholarly attention from isolated communication competencies towards a holistic understanding of communication readiness as an integrated graduate capability. By synthesising perspectives from communication studies, engineering education, English for Specific Purposes, competency-based education, outcome-based education, and graduate employability, the ECRI offers a comprehensive conceptual framework that reflects the communication realities of twenty-first-century engineering practice. Rather than replacing existing communication models, it integrates their complementary strengths into a unified theoretical structure capable of guiding curriculum development, communication assessment, and future research.

Overall, the analysis demonstrates that English communication readiness should be viewed as a multidimensional construct shaped by the interaction of academic communication, professional speaking, technical writing, listening competence, presentation skills, interpersonal communication, and communication confidence. These dimensions collectively prepare engineering students to communicate effectively within academic institutions, industrial organisations, and globally connected professional environments. The proposed English Communication Readiness Index therefore represents a significant conceptual contribution to engineering education by providing a coherent framework that bridges the gap between language proficiency and professional communication competence, ultimately supporting the preparation of graduates who are technically proficient, professionally confident, and communication-ready for the demands of the modern engineering profession.

6. CONCLUSION

The rapidly evolving landscape of engineering education has fundamentally transformed the competencies expected of engineering graduates. While technical expertise continues to remain the cornerstone of engineering practice, the ability to communicate effectively has emerged as an equally important determinant of academic success, professional competence, and long-term career advancement. Engineers today operate within multidisciplinary, multicultural, and technology-driven environments where communication serves as the bridge between technical knowledge and practical application. Consequently, English communication should no longer be regarded merely as an auxiliary language skill but as a strategic professional competency that enables engineers to collaborate, innovate, lead, and contribute meaningfully to society.

The present conceptual study was undertaken to address an important gap in engineering education literature by proposing the English Communication Readiness Index (ECRI) as a multidimensional framework for understanding communication readiness among undergraduate engineering students. The review of contemporary literature revealed that although communication has received considerable scholarly attention, existing research has predominantly examined communication through isolated dimensions such as speaking, writing, listening, or presentation skills. While these studies have

contributed significantly to the understanding of individual communication competencies, they have not adequately explained how these competencies interact to prepare students for the complex communication demands of modern engineering practice. This fragmentation has limited the development of comprehensive assessment models capable of representing communication as an integrated graduate capability.

To overcome this limitation, the present study conceptualises English communication readiness as a holistic construct comprising seven interrelated dimensions: Academic Communication, Professional Speaking, Technical Writing, Listening Competence, Presentation Skills, Interpersonal Communication, and Communication Confidence. Rather than functioning independently, these dimensions collectively represent the knowledge, skills, attitudes, and behavioural competencies required for effective communication in academic, professional, and global engineering environments. The proposed framework therefore shifts the focus from evaluating isolated language skills to understanding communication readiness as a comprehensive professional capability that develops progressively throughout engineering education.

A significant contribution of this study lies in its interdisciplinary theoretical foundation. By integrating concepts from Communicative Competence Theory, English for Specific Purposes (ESP), Competency-Based Education (CBE), Outcome-Based Education (OBE), and Graduate Employability, the ECRI provides a comprehensive explanation of communication readiness that reflects both educational theory and professional practice. This synthesis demonstrates that communication competence cannot be achieved through linguistic proficiency alone but requires the integration of contextual understanding, professional behaviour, interpersonal effectiveness, critical thinking, confidence, and adaptability. Such a multidimensional perspective is particularly relevant for engineering education, where communication increasingly determines graduates' ability to function successfully within collaborative and technology-intensive workplaces.

The proposed framework also carries important implications for curriculum development. Engineering institutions have traditionally addressed communication through standalone English language courses, often separating language learning from technical education. However, the findings of this conceptual study suggest that communication should be embedded throughout engineering curricula and integrated into technical subjects, laboratory activities, project-based learning, industrial internships, design reviews, seminars, and collaborative assignments. Such an integrated approach enables students to develop communication competencies within authentic engineering contexts, thereby strengthening both academic learning and professional preparedness. The ECRI therefore provides curriculum designers with a structured conceptual model for incorporating communication systematically across engineering programmes.

The framework is equally valuable for educators and assessors. Conventional communication assessment frequently emphasises grammar, vocabulary, reading comprehension, and writing accuracy, providing only a partial understanding of students' communication capabilities. The multidimensional nature of the ECRI encourages educators to adopt more authentic and competency-oriented assessment practices that evaluate presentations, technical documentation, collaborative interaction, professional discussions, reflective learning, and workplace communication. Such assessment methods more accurately represent the communication requirements encountered by graduates in professional engineering environments and contribute to the development of industry-ready professionals.

Another important implication relates to graduate employability. Contemporary employers consistently identify communication as one of the most influential competencies affecting recruitment, workplace integration, leadership potential, and career progression. Engineering graduates possessing strong communication abilities are better equipped to explain technical concepts, collaborate within multidisciplinary teams, negotiate solutions, manage projects, interact with clients, and assume leadership responsibilities. The ECRI directly addresses these expectations by identifying the communication dimensions most closely associated with professional success, thereby establishing a stronger connection between engineering education and industry requirements.

Although the present investigation is conceptual in nature and does not include empirical validation, it establishes a robust theoretical platform for future research. The proposed framework provides a

foundation for developing reliable and valid assessment instruments capable of measuring English communication readiness among engineering students. Future empirical investigations may employ exploratory and confirmatory factor analysis, structural equation modelling, and longitudinal research designs to validate the proposed dimensions, examine their interrelationships, and evaluate their influence on academic performance, employability, workplace effectiveness, and career development. Comparative studies across institutions, engineering disciplines, and cultural contexts may further strengthen the applicability and generalisability of the framework.

The originality of the English Communication Readiness Index lies in its ability to synthesise diverse educational perspectives into a unified conceptual framework specifically designed for engineering education. Rather than proposing another language proficiency model, the ECRI presents communication readiness as a dynamic and multidimensional graduate attribute that reflects the realities of twenty-first-century engineering practice. It recognises that successful engineers require far more than technical expertise; they must also possess the confidence, adaptability, interpersonal effectiveness, and professional communication skills necessary to thrive in increasingly global and digitally connected workplaces.

In conclusion, the English Communication Readiness Index represents a significant conceptual advancement in engineering communication research. It provides a coherent theoretical framework that bridges the gap between language education and professional engineering practice while responding to the communication expectations of modern industry. By conceptualising English communication readiness as a multidimensional construct, the study contributes to the continuing evolution of engineering education and offers valuable guidance for educators, curriculum developers, researchers, accreditation agencies, and policymakers. Ultimately, the framework supports the preparation of engineering graduates who are not only technically competent but also professionally confident, globally competitive, and capable of communicating effectively in the diverse and complex environments that characterise contemporary engineering practice.

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ETHICAL DECLARATIONS

Ethics Approval and Consent to Participate

This study is a conceptual research work based exclusively on the review and synthesis of published scholarly literature. It did not involve human participants, animals, personal data, or primary data collection. Therefore, ethics committee approval and informed consent were not required.

Consent for Publication

Not applicable.

Availability of Data and Materials

No datasets were generated or analysed during the current study. All information supporting this conceptual framework is derived from publicly available scholarly sources cited in the reference list.

Competing Interests

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Author Contributions

The authors solely conceived the study, conducted the literature review, developed the conceptual framework, interpreted the findings, and prepared the manuscript.

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Declaration of Originality

The authors declare that this manuscript is an original work that has not been published previously and is not under consideration for publication elsewhere. All sources used in the preparation of this study have been appropriately acknowledged and cited.