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INDUSTRIAL ENGINEERING IN MONGOLIA: CAREER PATHS, AWARENESS, AND FUTURE OPPORTUNITIES

Bachelor's Thesis

By

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Statutory Declaration

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I hereby affirm in lieu of an oath that I provided the submitted bachelor thesis

INDUSTRIAL ENGINEERING IN MONGOLIA: CAREER PATHS, AWARENESS, AND FUTURE OPPORTUNITIES

I did not use any sources other than those stated. In case that the work is additionally submitted on a data medium, I declare that the written and the electronic form are completely identical. The work was not submitted in the same or similar form to any examination authority.

Ulaanbaatar/Nalaikh, 28/05/2026

Place, Date

Signature

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Abstract

This paper presents findings on employment outcomes, skills utilization, employer recognition, and value proposition of Industrial Engineering (IE) at the German-Mongolian Institute for Resources and Technology (GMIT). Through mixed-method Graduate Tracer Study (GTS) design, this research triangulated quantitative responses from 35 out of 49 graduates (response rate: 71.4%, cohorts 2020–2025) with qualitative interviews of three graduates. The study is guided by three research questions addressing labor market insertion (RQ1), employer recognition (RQ2), and future outlook (RQ3) of IE at GMIT.

Graduates from GMIT's IE program have an employment rate of 85.7% and median time-to-employment of three months. Industry distribution among employed graduates is led by Mining (38.7%), mirroring Mongolia's status as a resource-driven economy. Despite strong employment outcomes, IE is still perceived poorly by employers (mean 2.79/5). This key finding supports the study's hypothesis that GMIT IE graduates are already creating value within industry functionally, but IE remains unrecognized institutionally. Respondents most frequently cited gaps between academic training and industry needs around data analytics skills (+0.94 on 5-point scale) and knowledge of target industries (59.4%). Qualitative interview data highlight systems thinking as the most consistently applicable skill among graduates.

This research provides the first systematic body of empirical evidence on GMIT IE graduate outcomes. Based on these findings, we offer twelve specific recommendations for program improvement referenced to the program's Module Handbook (ACA-PO-022-v1.0, June 2024) [21].

Keywords: *Industrial Engineering; GMIT; Graduate Tracer Study; Employment Outcomes; Skill Gap; Employer Awareness; Systems Thinking; Mongolia; Mixed-Method Research*

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1 Introduction

1.1 Background of the Study

Industrial Engineering (IE) is a multidisciplinary engineering field focused on the design, analysis, improvement, and optimization of complex systems involving people, materials, information, equipment, and energy. Unlike traditional engineering disciplines that focus on specific technical domains, IE is distinguished by its systems-level perspective and its ability to improve efficiency and performance across a wide range of industries and services [1]. The discipline originated from the scientific management movement led by Frederick Winslow Taylor in the early twentieth century and has since evolved to include operations research, quality control, supply chain management, human factors, and data-driven process optimization [2,6]. Today, IE is recognized internationally by organizations such as the Institute of Industrial and Systems Engineers (IISE) [1].

In Mongolia, Industrial Engineering is still a relatively new academic discipline. Following Mongolia's economic transition after 1990, the rapid growth of the mining sector created demand for engineers capable of managing complex operational systems, particularly in major projects such as Oyu Tolgoi and Tavan Tolgoi. This demand contributed to the establishment of the German-Mongolian Institute for Resources and Technology (GMIT) in 2012 through cooperation between Mongolian and German institutions.

GMIT's Bachelor of Industrial Engineering program was created to develop engineers with systems thinking, process optimization, and analytical skills suited to Mongolia's industrial economy. By 2025, the program had produced several graduate cohorts working in mining, construction, logistics, IT, manufacturing, and sustainability consulting, including positions in international organizations. Despite these outcomes, no systematic empirical study had previously examined the employment outcomes, skill utilization, or organizational contributions of GMIT IE graduates. This thesis addresses that gap.

1.2 Research Problem

The core research problem addressed in this study is the lack of systematic empirical evidence on the employment outcomes and professional integration of GMIT Industrial Engineering graduates. There are three levels at which this problem exists: At an individual level, GMIT students and graduates of IE lack formal evidence-based data surrounding their career opportunities upon graduation. Informal channels and hearsay can only assist them so far. Without easily accessible and comprehensive

information, students and graduates will not be able to make well-informed decisions regarding their area of specialization, skills training, and career goals. Research in higher education has shown that a lack of career information can have detrimental effects on career readiness and vocational identity [15].

At an organizational level, GMIT faculty and staff currently lack enough empirical data to understand how their program meets job market demand. How can we know which improvements to make to the curriculum if we don't know what careers our graduates are taking, what skills employers are looking for, and where gaps in graduate knowledge exist? Programmatic decision-making through evidence-based curriculum development has been cited as one of the most important ways to keep curriculum relevant and graduates competitive [3,4].

At a sociological level, low employer awareness of IE is reinforced by a lack of published evidence documenting the contributions of our graduates. If employers do not have access to information regarding where graduates are employed and what positive impact they make in their workplace, they will not have a clear understanding of what those graduates do. This creates a cycle of low awareness and demand for the profession.

In addition, the study addresses a terminological and classification gap. While Industrial Engineering is globally recognized, it is not formally defined in Mongolia's occupational classification system. As a result, graduates performing IE-related functions are often categorized under related roles such as project coordinator, operations analyst, or process engineer. This classificatory invisibility further complicates labor market analysis and contributes to weak institutional recognition of the discipline.

Schomburg emphasizes that developing systematic, institution-specific graduate outcome data is a key priority in higher education quality assurance, particularly for emerging programs [4]. This study directly responds to that need.

1.3 Research Objectives

The primary objective of this study is to examine the employment outcomes and

professional positioning of Industrial Engineering graduates of GMIT.

The specific objectives are:

- To identify the main industries and sectors employing Industrial Engineering

Graduates

- To analyze the professional roles and responsibilities performed by graduates
- To evaluate the key technical and soft skills utilized in their work
- To assess employer awareness and understanding of Industrial Engineering
- To examine how Industrial Engineering graduates contribute to organizational

performance and value creation

1.4 Research Questions

This study is guided by three main research questions reflecting the core themes of the study: career paths, awareness, and future opportunities.

Main Research Questions

RQ1. Career Paths

How are Industrial Engineering graduates in Mongolia positioned within the labor market in terms of employment sector, professional role, and time required to obtain their first job?

RQ2. Awareness

How well is the Industrial Engineering profession understood and recognized by employers in Mongolia?

RQ3. Future Opportunities

What future opportunities exist for Industrial Engineering graduates in Mongolia based on current employment patterns, skill utilization, and industry needs?

Sub-Questions

- In which industries and sectors are graduates employed?
- What roles and responsibilities do they perform?
- Which technical and soft skills are most frequently used?
- How does skill usage during university compare with workplace requirements?
- How do graduates contribute to organizational value creation?

1.5 Significance of the Study

This study makes four interconnected contributions: academic, institutional, practical, and strategic.

Academically, it contributes to Graduate Tracer Study (GTS) literature in developing economy and emerging engineering education contexts, which remain underrepresented

in international research [3,7]. By using a mixed-method GTS design that combines quantitative analysis with qualitative career narratives and impact cases, the study demonstrates the value of moving beyond standard employment indicators.

Institutionally, it provides GMIT with the first systematic empirical evidence base for evaluating and improving its IE program. Findings on curriculum gaps (e.g., data analytics and industry-specific knowledge), graduate career paths, and employer awareness offer a direct foundation for curriculum review and strategic development.

Practically, the study gives current and prospective students clear, evidence-based information on career pathways, required skills, salary levels, and industry entry conditions—filling a critical information gap highlighted in career development research [15,16].

Strategically, it represents an initial step toward strengthening the institutional recognition of Industrial Engineering in Mongolia. The documented evidence of graduate impact supports employer awareness initiatives, professional network development, and policy discussions on formal recognition of IE in the national occupational classification system.

2 Literature Review

2.1 Industrial Engineering and Its Role in Modern Industries

IEs hold a unique place in engineering taxonomy, because rather than focusing on engineering a particular product or technology per se, Industrial Engineering focuses on how people, materials, information, equipment, and energy are optimized and flow together as an integrated system. According to The Institute of Industrial and Systems Engineers, Industrial Engineers are “concerned with designing, improving, and installing integrated systems of people, materials, information, equipment, and energy” [1]. Due to IE’s systems-level emphasis across industry-agnostic functional improvements, Industrial Engineering inherently draws insight from any and all technical disciplines while also facing historical difficulty being recognized as its own category in labor markets built around technical disciplines.

Engineering focused on how production and workers were optimized under industrialization evolved several times in response to the changing world. From Frederick Winslow Taylor’s principles of scientific management [6], industrial engineering has taken on motion study and ergonomics, statistical quality control, operations research,

lean manufacturing and Six Sigma, and more recently data science and digital manufacturing have been integrated into the practice [2,9].

Today, industrial engineers can be found working in any sector. From designing and improving manufacturing systems and capacity planning to designing logistics networks and inventory systems to streamlining patient flow and improving patient experience in hospitals to assisting with production planning, equipment paring, and maintenance optimization in mining and beyond. Industrial engineers can even be found in IT-focused roles and service industries where they work to analyze and improve workflows and organizational performance. For this reason, even in countries where IE is not a formally recognized job title, there has consistently been demand for graduates with IE training.

According to the World Economic Forum's Future of Jobs Report, "top skills underpinned by systems analysis include analytical thinking and problem-solving, process optimization, and data-driven decision-making," which are some of the skills projected to have the highest growth rate in demand between 2023 and 2027 [8]. Therefore, we can conclude that while the title Industrial Engineer may not be universally recognized, demand for professionals with IE skill sets is indeed on the rise globally.

2.2 Employment Outcomes of Engineering Graduates

Research on graduate employment outcomes is a well-established area within higher education studies that examines how graduates transition into the labor market. It typically considers employment status, time to first job, occupational relevance, salary, and career progression, providing a multi-dimensional assessment of program effectiveness and graduate readiness [4,11].

Engineering graduates generally show higher employability than graduates from social sciences, humanities, and arts, reflecting sustained global demand for technical and analytical skills. Blom and Saeki's study of engineering graduates in developing economies found that programs emphasizing problem-solving and systems thinking achieve stronger employment outcomes than those focused mainly on theory [19]. However, the degree of alignment between academic training and workplace needs varies across disciplines, institutions, and labor market contexts.

International GTS research consistently shows that many engineering graduates—especially from interdisciplinary fields such as Industrial Engineering—work in roles not formally labeled as their discipline, while still applying their core competencies directly [17]. This "functional match without formal classification" is particularly relevant for GMIT

IE graduates in Mongolia, where Industrial Engineering is not yet a formally recognized occupational category.

Yorke's employability framework defines employability as a combination of skills, knowledge, and personal attributes that enable graduates to obtain and succeed in employment [15]. This definition is especially useful here because it separates employability from formal job titles or disciplinary recognition. From this perspective, graduates who effectively apply IE competencies in non-IE titled roles are still clearly employable. This framework helps interpret the "Embedded IE" pattern identified in this study.

2.3 Graduate Tracer Study (GTS) Methodology

2.3.1 Concept and Purpose of Graduate Tracer Studies

Graduate Tracer Studies (GTS) are systematic empirical studies that track graduates' career trajectories after leaving higher education, with the aim of assessing the alignment between academic programs and labor market needs [3]. The methodology emerged in the 1970s–1980s through initiatives involving UNESCO, the European Training Foundation, and national research bodies, and is now widely used in global higher education quality assurance systems [4].

The main rationale for GTS is that internal academic indicators alone are insufficient to evaluate program effectiveness. Instead, labor market outcomes—such as employment rate, time to employment, salary, career progression, and skill utilization—provide external validation of whether graduates are adequately prepared for professional work [11]. This is especially important for relatively new programs such as GMIT's IE program, which lack long-term historical performance data.

UNESCO's guidelines identify three key quality indicators for program evaluation: (1) disciplinary relevance, or the match between graduates' jobs and their field of study; (2) employer awareness, or the extent to which employers understand graduates' disciplinary background; and (3) skill alignment, or the match between university training and workplace requirements [3]. This study directly addresses all three indicators.

2.3.2 GTS Methodology and Indicators

Graduate Tracer Studies typically involve administration of structured survey questionnaires sent via post, email, or increasingly through online interfaces like Google Forms and SurveyMonkey [4,11]. Questionnaires can include closed questions (rating scales, multiple choice etc.) suitable for quantitative analysis as well as qualitative open

questions. Typical indicators gathered include: employment status, time to first job, employment sector, role/job title, relevance of studies, salary level.

One particular approach has been gaining prevalence in recent GTS literature; namely pairing the survey questionnaire with qualitative interviews. Schomburg notes that purely quantitative indicators cannot answer questions regarding how education affects job performance within the workplace and instead interviews help build explanatory power when interpreting results and proposing recommendations [4]. This research takes a similar mixed-method approach by supplementing quantitative results of the survey (n=35) with qualitative data gathered from interviews (n=3).

Likewise the Schomburg framework highlights expected validity thresholds depending on the size of the graduate population under study. Response rates of 50% or greater can be suitable when dealing with small numbers of graduates (<200), and an adequate response for larger populations is around 30–40% [11]. Due to the small size of GMIT's IE graduates, we can reasonably assume that our 35 respondents make up a significant portion of the population.

2.4 Skill Alignment Between University Education and Labor Market Needs

Skill alignment—the match between competencies gained through education and those required in employment—is a widely studied issue in higher education, reflecting concerns about the relevance of university training to labor market needs [5,8].

Research identifies two main types of skill mismatch in engineering graduates. Vertical mismatch occurs when graduates work in jobs below their qualification level, often indicating underemployment. Horizontal mismatch occurs when graduates work outside their field of study but still apply related competencies [17]. For GMIT IE graduates, horizontal mismatch is more common and analytically relevant, as many work in roles where IE-related functions are performed under different job titles.

International studies consistently show that employers demand soft skills such as communication, problem-solving, and adaptability at higher levels than universities typically develop them, while some specialized technical skills are underutilized in early career stages [16]. This pattern is expected in the GMIT IE context and is directly examined in Chapter 4.

The WEF Future of Jobs Report highlights rapidly increasing global demand for data analysis, AI literacy, and digital tool proficiency across industries [8]. For engineering

programs, this means data analytics is no longer a specialized skill but a core competency. Graduates who do not possess these skills find themselves increasingly marginalized from the workforce.
In Mongolia, there is an added urgency to this issue due to the digitization of the mining sector. Modern large-scale mines are producing large quantities of operational data from sensors, production machinery, maintenance software programs and geological databases. There is an increasing demand for engineers capable of interpreting and leveraging this data towards informed decision-making, which has yet to be addressed on a national scale across engineering programs.

2.5 Value Creation and Impact of Engineering Roles

In addition to employment rates and skill development measures, research into engineering education and graduate attribute evaluation is increasingly focused on value creation of engineering graduates - how their professional activities make a demonstrable and quantifiable difference to the performance, efficiency, and competitiveness of the organizations with which they work [9]. Industrial engineers create value by increasing efficiency (doing work faster/slowing), improving quality (making outputs more reliable/uniform), optimizing processes (reshaping the way work is done to eliminate waste and increase throughput), and supporting decisions (helping organizations make better informed strategic and operational decisions through analysis of relevant data). These four mechanisms correspond directly to the core competency domains of IE education and are directly testable through the value creation indicators included in this study's survey instrument.

Khosrow-Pour's analysis of engineering graduates in digital transformation roles identifies IE-trained professionals as disproportionately represented among high-value contributors to organizations undergoing operational transformation, attributing this to their unique capacity to integrate technical systems analysis with organizational change management [9]. This finding is particularly relevant to the Mongolian mining sector, which is currently undergoing a significant technological transition toward more data-intensive and digitally connected operational environments.

2.6 Industrial Engineering in Developing Economies

The application and recognition of Industrial Engineering in developing and transition economies follows a consistent pattern that is relevant to the Mongolian context. In rapidly industrializing economies—especially those driven by natural resources—demand for IE competencies often appears not through formal IE job creation, but through the integration of IE methods into broadly defined engineering and management

roles. Functions such as scheduling, optimization, and process improvement are frequently carried out by engineers labeled as “production engineers,” “operations managers,” or “project coordinators,” even when their work corresponds directly to Industrial Engineering practice [17,19].

This pattern of “functional embeddedness without formal recognition” has been observed in several developing economies, including India, Brazil, and parts of Southeast Asia, where IE is either absent from occupational classification systems or only recently introduced. Blom and Saeki show that in India, multidisciplinary engineering graduates are often classified under adjacent job categories, and their IE-related work becomes visible only through detailed analysis of job tasks rather than job titles [19].

The key implication is that in contexts where IE is functionally present but not formally recognized, the most effective interventions are not simply increasing graduate supply, but strengthening employer awareness and institutional recognition. This directly informs the recommendation framework presented in Chapter 6.

2.7 Research Gap and Conceptual Framework

The preceding review shows that although Graduate Tracer Study (GTS) methodology is well established internationally, and frameworks on skill alignment and value creation are widely used, no published study has systematically applied these approaches to GMIT Industrial Engineering graduates. This represents both a gap in the academic literature on engineering education in Mongolia and a lack of structured evidence for GMIT, its students, and industry partners.

To address this gap, this study uses a mixed-method, impact-oriented GTS design combining three components: a quantitative analysis of employment and skills following standard GTS methods; a qualitative component based on career narratives and impact cases, in line with Schomburg [4] and Creswell and Plano Clark [10]; and a strategic analysis that translates findings into actionable recommendations.

The conceptual framework is based on the three guiding research questions. Measures connected to RQ1 (Career Paths) include employment status, sector, time-to-hire, and promotion data. Measures tied to RQ2 (Awareness) include employer knowledge scores and interviews. Measures related to RQ3 (Future Opportunities) include skill gaps, value created findings, and interviews. The conceptual framework both captures where we are now (diagnostic) and allows for action.

3 Methodology

3.1 Research Design and Philosophy

A mixed method research design has been utilized for this study. Mixed methods involve the collection and analysis of both quantitative and qualitative data. This methodology was chosen because it is situated within a pragmatist epistemology. Pragmatism argues that researchers should use whatever methods allow them to answer their research questions best, rather than prioritizing quantitative or qualitative methods out of ideological reasons. Pragmatism has been argued to be best-suited foundation for applied research in higher education [10].

The quantitative component of the design follows the established Graduate Tracer Study survey methodology, generating descriptive statistics on employment outcomes, sector distribution, skill utilization, and value creation across a sample of 35 graduates. The qualitative component employs semi-structured in-depth interviews with three strategically selected graduates, generating career narratives, impact case evidence, and interpretive depth that cannot be captured through survey instruments alone.

This design is described by Creswell and Plano Clark as a 'concurrent triangulation design' [10], in which quantitative and qualitative data are collected independently and then integrated during the interpretation phase to produce a more complete and robust picture of the phenomenon under investigation than either method could provide alone. In the context of this study, the quantitative data establishes the scope and magnitude of employment and skill patterns across the graduate population, while the qualitative data provides the explanatory mechanisms and individual-level contextualization that give these patterns their strategic meaning.

3.2 Research Framework

The research framework integrates three analytical components, each corresponding to a distinct layer of the investigation.

The Quantitative Employment Outcomes Component addresses employment status, time to first job, industry sector and company type, job function and role, salary distribution, career progression, and job relevance to IE. This component generates the descriptive statistical picture required to answer RQ1.

The Awareness and Perception Component addresses employer and colleague understanding of IE (measured on a 5-point scale), graduate recommendations for the program, and graduates' self-assessment of whether their IE background is essential to

their current role. This component provides the quantitative and narrative evidence required to answer RQ2.

The Skill Utilization and Value Creation Component addresses university vs. workplace skill utilization (measured on a 5-point scale for 13 competencies), perceived curriculum gaps, organizational responsibilities, measurable improvements attributable to IE training, and self-assessed organizational and national development impact. Combined with the qualitative interview impact cases, this component provides the evidence base for answering RQ3.

3.3 Data Collection Methods

3.3.1 Survey (Google Forms Questionnaire)

The primary quantitative data collection instrument is a structured questionnaire developed in Google Forms and distributed digitally to GMIT IE graduates. . The survey items were based on general sets of GTS indicators as described by UNESCO [3] and Schomburg [11]. Furthermore, there were questions that explored value creation and impact on the organisation which goes beyond the general scope of GTS. These additional questions were implemented to fit the impact-centred approach of this research. Questions ranged from topics including job title and salary range, to skill implementation throughout university and on the job. The questionnaire includes 23 questions in the following categories: (1) General information about graduate (name, year of graduation, gender, area of residence); (2) Employment status and time of job seeking; (3) Employment details (field, type and size of company, occupational area and job title, salary); (4) Career development and contribution to organisation; (5) Usage of skills you learned throughout university and in your job (13 questions using a 5-point Likert scale); and (6) Your opinion on value creation, quality of the programme, and employer recognition. The questionnaire was shared through email and social media connections available to GMIT IE graduates and received 35 total responses from classes 2020–2025.

To protect respondent confidentiality, names were collected for research transparency but are not reported in statistical analyses. Individual quotes from open-text responses are attributed only by graduation year and sector unless explicit permission to use the respondent's name was granted through the interview process.

3.3.2 In-Depth Semi-Structured Interviews

The qualitative data collection component comprises in-depth semi-structured interviews with GMIT IE graduates. The original interview plan, formulated in accordance with GTS best practices [4,12], called for a purposive sample of six participants: two to three high-

performing graduates; two average-performing graduates; one graduate employed outside IE-aligned roles; and one employer of IE graduates. This participant profile was designed to capture diverse perspectives on career development, the value of IE education, and employer awareness.

However, in practice, only three interviews were successfully completed during the data collection period. Each of the three completed interviews was conducted with graduates in different industries and at varying stages in their careers. Although the sample size is small, qualitative depth was achieved through variation in interviewees. All interviews followed the same guide of six open-ended questions. Questions included: (1) career path from graduation to present day; (2) significant career breakthrough; (3) progression of professional roles/responsibilities; (4) how IE education has affected career choices; (5) greatest challenges in your career and how you overcame them; and (6) advice for current IE students. The semi-structured format was used to allow the interviewer to establish common themes across interviews, while permitting exploration of new ideas as they arise [12]. Interviews were conducted in English and Mongolian according to participant preference, recorded with participant consent, and transcribed verbatim for analysis.

3.3.3 Impact Case Analysis

In addition to the survey and interviews, the study incorporates a specific impact case analysis sub-component. Three impact cases—one per interview participant—are constructed from the interview transcripts and supplementary information provided by participants, documenting specific, organizationally significant contributions that can be attributed to their IE training. Impact cases follow a structured format: organizational context; specific challenge addressed; IE methods or competencies applied; and outcome or impact achieved. This approach, adapted from the Research Excellence Framework impact case study methodology, provides the evidence for the value creation dimension of the research framework.

3.4 Sampling Strategy and Participants

The target population for this study is all graduates of GMIT's Bachelor of Industrial Engineering program across cohorts 2020–2025. A census method of survey distribution was used—that is, instead of drawing a probabilistic random sample from the population of graduates, all reachable graduates were asked to complete the survey—due to the low number of graduates, which renders obtaining a random sample that is statistically representative of the population difficult [11].

The 35 survey respondents are graduates from across six cohorts (2020: n=1, 2021: n=5, 2022: n=7, 2023: n=7, 2024: n=6, 2025: n=9). Although the low number of

graduates per cohort does not allow for statistically significant comparisons across cohorts, having respondents from every cohort allows for some analysis of career stage impacts longitudinally.

Three graduates were chosen for interviews using purposive sampling [12]. Participants were selected based on (a) spanning career stages, sectors, and employment types; (b) having at least six months of work experience after graduating from the program; and (c) being able and willing to provide rich and reflective insight into their career progression. Orgilsaikhan Munkhbaatar (2021 graduate, mining/EPCM), Oyungerel Ganbaatar (2025 graduate, telecommunications), and Zanabazar Altangerel (2022 graduate, heavy machinery/mining) were selected, as they cover the study's three primary employment sectors (Mining and others) and varied career paths (quick promotion, operational track, analytic track).

3.5 Variables and Measurement

The study analyzes three categories of variables. Employment variables (categorical and ordinal) include employment status (employed/studying/unemployed), time to first job (categorical: before graduation / 0–3 months / 4–6 months / 7–12 months / more than 1 year), industry sector (categorical), company type and size (categorical), job function (categorical), salary range (ordinal), and career progression (categorical). These variables are analyzed descriptively using frequencies and percentages.

Skill variables are measured on a five-point Likert scale (1 = very low utilization; 5 = very high utilization) for 13 competencies, applied twice—once for university context and once for workplace context. The gap between workplace and university means is the primary analytical output, identifying areas of curriculum-industry misalignment. The The 13 skills that are measured include: data analytics, process improvement, operations management, supply chain management, quality management, project management, problem solving, communications, teamwork, leadership, time management, critical thinking, and adaptability.

Value creation variables include: self-assessed measurable improvement contribution (1–5 scale); perceived value of IE background in current job (1–5 scale); perceived contribution to national economic development (1–5 scale); and organizational responsibilities (multi-select categorical). Open-text responses are analyzed qualitatively. Employer awareness is assessed using a single five-point scale item (1 = very poorly understood; 5 = very well understood).

3.6 Data Analysis Methods

Quantitative data from the survey were exported from Google Forms to Microsoft Excel for analysis. Descriptive statistics were calculated including frequencies, percentages, and means. For skill variables, means were calculated using available data (listwise deletion for items with missing responses), and the gap between workplace and university means was computed for each of the 13 competencies. The resulting gap values are the primary analytical output of the skill alignment analysis.

Qualitative interview data were analyzed using Braun and Clarke's reflexive thematic analysis framework, a six-phase approach comprising: (1) data familiarization through verbatim transcription and repeated reading; (2) initial coding—systematic annotation of all data features relevant to the research questions; (3) theme development through collation of related codes into candidate themes; (4) theme review and refinement through iterative comparison of themes with the coded data; (5) theme definition and naming; and (6) report production integrating themes into the analytical narrative [12]. Thematic analysis was applied across all three interview transcripts, with cross-case comparison used to identify themes that were consistent across different participants, contexts, and sectors.

3.7 Research Validity and Reliability

Several measures were taken to strengthen the validity and reliability of the study's findings. For the quantitative component, construct validity was supported by using established GTS survey indicators [3,11] and validated skill competency lists [1,8] rather than creating entirely novel measures. Convergent validity is assessed through the triangulation of quantitative employment and skill data with qualitative interview evidence—where both data sources point to the same conclusion (e.g., systems thinking as a key IE outcome), confidence in the finding is strengthened.

For the qualitative component, credibility was enhanced through: verbatim transcript analysis (rather than researcher paraphrase); cross-case comparison to identify consistent patterns rather than relying on any single participant's account; and thick description in the reporting of interview evidence, allowing readers to evaluate the basis for the interpretive claims made. Member checking—sharing key qualitative findings with two of the three interview participants for review—was used to verify that the researcher's interpretation of their accounts was accurate.

A potential threat to reliability was the study's reliance on self-report data, both quantitatively (Likert scale ratings) and qualitatively (verbatim interview data). The social desirability effect, or bias introduced by asking respondents to portray themselves and

their experiences in the best possible light, was not completely avoided. However, it should have been lessened by the respondents' ability to anonymously complete the survey (they were not asked to identify themselves for purposes of statistical validity) and by the semi-structured interview format, which promoted thoughtful and balanced responses.

3.8 Ethical Considerations

This research was carried out per national and institutional ethical guidelines and principles on research ethics in educational and social science research. Survey and interview respondents all gave informed consent before data collection began. Prior to giving informed consent, respondents were informed about the study's purpose, their right to participate (or not) without penalty, their right to withdraw their data up until a chosen deadline with no penalty, and about how confidentiality would be maintained. Interviewees were informed that their names would be used in this thesis when quoting them directly, and written informed consent was gathered.

Survey responses were kept on a Google account password-lked to the researcher. Recordings/transcripts from interviews are kept on password-protected computers/devices and will never be distributed to a third party. Respondents were not compensated with money nor would they face academic consequences for not participating. Measures were taken to ensure that all responses were voluntary.

3.9 Limitations

There are three primary limitations to this study. The first is that only three interviewees took part in the study despite six being originally planned. No employers took part in the study which limits the pool of evidence available to answer RQ2 (employer awareness). Because of this, analysis into awareness on the employer-side is based on graduates' perception of employers' awareness instead of employers themselves. Future studies will need to recruit employer participants in order to more fully understand the awareness-side of the issue.

The second limitation is that this study relies on self-reported data. Skill utilization ratings are merely graduates reporting how competent they feel. While self-reported data is common amongst GTS literature [4,11], there is always a risk that perception biases will affect responses and there are no controls for this.

The final limitation is that sample sizes within each graduate cohort were too small (n=1 for the 2020 graduates) to make any concrete cohort-by-cohort longitudinal

comparisons. This study should be seen more as a cross-sectional analysis of the graduate population at various stages in their careers.

4 Results and Analysis

This chapter presents findings organized by research question. The study's core argument—that GMIT IE graduates are functionally embedded in industry and creating measurable value, yet the discipline is not institutionally recognized—is systematically evidenced across all analytical sections. Cross-references to figures and tables are provided throughout when data presented earlier is discussed further.

4.1 Sample Overview and Respondent Profile

Responses from graduates from cohorts 2020–2025 numbered 35 of 49 graduates overall, accounting for 71.4% of the population and surpassing the minimum population sampling validity percentage (>50%) established by GTS [11]. Female graduates (n=21, 60.0%) outnumbered male graduates (n=14, 40.0%). Most respondents (n=28, 80.0%) were situated in Mongolia at the time of distribution; five graduates were working or studying abroad (n=5, 14.3%), demonstrating geographical spread and corroborating GMIT IE graduates' presence in international labour markets. There were no restrictions on which graduating classes could respond to the survey, with the largest group belonging to cohort 2025 (n=9, 25.7%), followed by equal respondents from 2022 and 2023 (n=7). This represents a sample spread across five years of graduate development.

4.2 RQ1 – Career Paths: Employment Outcomes

4.2.1 Employment Status

Out of 35 respondents, 27 (77.1%) worked full-time, 2 (5.7%) worked part-time and one respondent (2.9%) was self-employed. These categories result in an overall employment rate of 85.7%. Three respondents (8.6%) were engaged in further study and 2 (5.7%) were unemployed and seeking work. Table 4.1 presents the full distribution.

Employment Status	n	%
Employed full-time	27	77.1%
Employed part-time	2	5.7%
Self-employed	1	2.9%
Pursuing further studies	3	8.6%
Unemployed – seeking job	2	5.7%
Total	35	100.0%

Table 4.1. Employment status distribution of GMIT IE graduates (n=35). Source: Primary survey data, 2025.

The 85.7% combined employment rate exceeds typical benchmarks of 75–80% for engineering graduates in developing economy contexts [19]. The low unemployment rate of 5.7% confirms active labor market demand for GMIT IE graduate competencies.

4.2.2 Sectoral Distribution

The Mining sector dominates GMIT IE graduate employment, accounting for 12 of 31 respondents who provided industry data (38.7%). This is followed by Manufacturing and Construction/Projects (each n=3, 9.7%) and IT/FinTech (n=2, 6.5%). The distribution is presented in Table 4.2 and visualized in Figure 1 below.

Industry / Sector	n	%
Mining	12	38.7%
Manufacturing	3	9.7%
Construction / Projects	3	9.7%
IT / Software / FinTech	2	6.5%
Logistics / Supply Chain	1	3.2%
Tourism	1	3.2%
Consulting Services	1	3.2%
International Trade	1	3.2%
Education	1	3.2%
Carrier Networks	1	3.2%
Other / Unspecified	5	16.1%
Total (with data)	31	100.0%

Table 4.2. Sectoral distribution of employed GMIT IE graduates. Source: Primary survey data, 2025.

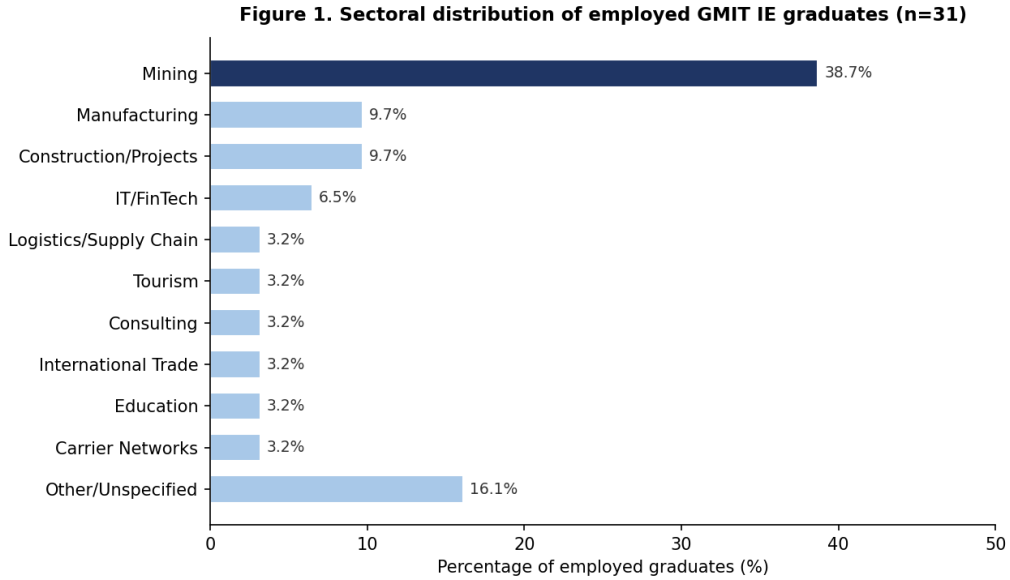

Figure 1. Sectoral distribution of employed GMIT IE graduates (n=31). Source: Primary survey data, 2025.

As shown in Figure 1 and Table 4.2, the Mining sector concentration directly reflects Mongolia's economic structure, where mining contributes 23–25% of GDP and over 80% of export revenue [13,14]. Large-scale mining operations represent the most operationally complex industrial environments in Mongolia—precisely where IE competencies in production planning, maintenance optimization, logistics coordination, and quality management (INDE405) are most applicable. The simultaneous presence of graduates in IT, sustainability consulting, and international project management (Oman) confirms emerging career diversification beyond the extractive sector core.

4.2.3 Time to First Employment

Seven respondents (20.6%) secured employment before graduation; 15 (44.1%) found their first job within zero to three months. Combined, 22 respondents (64.7%) entered the labor market within three months—substantially exceeding Schomburg's six-month GTS benchmark of 60–70% [4,11]. Table 4.3 presents the full time-to-employment distribution, including cumulative percentages.

Time to First Job	n	%	Cumulative %
Before graduation	7	20.6%	20.6%
0–3 months	15	44.1%	64.7%
4–6 months	8	23.5%	88.2%
7–12 months	2	5.9%	94.1%
More than 1 year	1	2.9%	97.1%

Not applicable / no data	2	5.9%	—
Total	35	100.0%	—

Table 4.3. Time to first employment after graduation (n=35). Source: Primary survey data, 2025.

The cumulative 88.2% employment within six months of graduation is particularly notable given the low employer awareness of IE as a formal discipline (as presented in Section 4.3 and Figure 4). This confirms that employers hire GMIT IE graduates for demonstrated competencies—systems thinking, analytical capability, project coordination—independently of formal disciplinary label recognition.

4.2.4 Job Relevance and Career Progression

Graduates were asked to rate how related their current job was to IE on a scale of 1-5 (1 = not related, 5 = directly related). A score of 3.30 represents an average connection to IE amongst respondents. The mode was a score of 3 (n=18, 51.4%), followed by those who indicated their job is directly related to IE with a score of 5 (n=6, 17.1%) and those who indicated their job was not related to IE with a score of 1(n=3, 8.6%). The average score falls in between related and not related because of the occurrence of the previously mentioned 'Embedded IE' phenomenon from Section 5.3, graduates working in positions where they use their IE knowledge and skills but are not considered an IE position by the organization.

As for career advancement (n=33): 10 individuals (30.3%) have switched jobs for a better opportunity, six individuals (18.2%) have been promoted once, and five individuals (15.2%) have been promoted more than once. Finally, ten respondents have remained in the same position, mostly consisting of students from the 2024–2025 working during their first or second year out of college. Overall, roughly 63.6% of working graduates have had some form of positive movement in their careers. Table 4.4 shows both metrics together.

Indicator	Category	n	%
Job Relevance to IE	Not related (1–2)	4	12.1%
	Moderately related (3)	18	54.5%
	Substantially/directly related (4–5)	11	33.3%
	Mean score	3.30	—
Career Progression	Same position	10	30.3%
	Promoted once	6	18.2%
	Promoted multiple times	5	15.2%

	Changed jobs (better opportunity)	10	30.3%

Table 4.4. Job relevance to Industrial Engineering and career progression (n=33). Source: Primary survey data, 2025.

4.2.5 Company Type, Size, and Salary

Among employed respondents (n=29), 14 (48.3%) worked in local Mongolian companies and 13 (44.8%) in international companies. Large organizations (250+ employees) dominated (n=17, 58.6%), consistent with the Mining sector concentration. Salary information was collected from 34 respondents using the Google Forms survey and is shown in Figure 3.

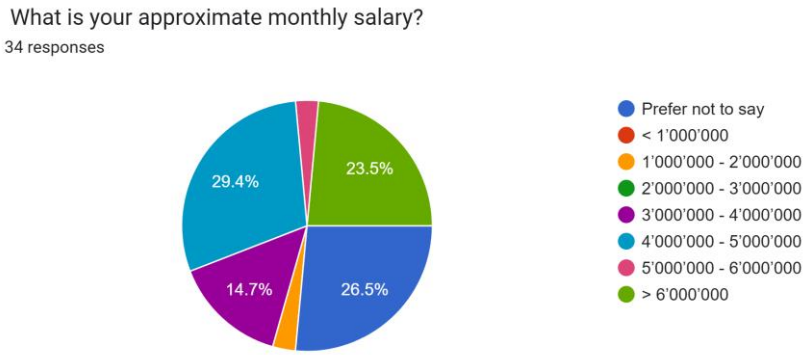

Figure 3. Monthly salary distribution of employed GMIT IE graduates (n=34). Source: Primary survey data, 2025.

Figure 3. Salary levels. As Figure 3 illustrates, salaries among respondents were most frequently in the range MNT 4,000,000–5,000,000 per month (29.4%), followed by >MNT 6,000,000 (23.5%) and MNT 3,000,000–4,000,000 (14.7%). With Mongolia's average wage across formal sectors sitting at around MNT 1,650,000 in 2022 [13], this means that most GMIT IE graduates make 2.4x higher than the national average.This salary premium confirms that the labor market assigns substantial value to GMIT IE competencies, independent of formal disciplinary recognition.

4.3 RQ2 – Awareness: Employer Understanding of Industrial Engineering

Graduates assessed how well their coworkers or employer understand Industrial Engineering using a five point scale (1=very poorly; 5=very well). The average response was 2.79 (n=34), which falls below the midpoint of the scale. Table 4.5 presents the distribution, with Figure 4 providing the visual representation from the survey data.

Rating	Description	n	%
1	Very poorly understood	3	8.8%
2	Poorly understood	12	35.3%
3	Moderately understood	11	32.4%
4	Well understood	5	14.7%
5	Very well understood	3	8.8%
Mean / n	2.79	n=34	—

Table 4.5. Perceived employer/colleague understanding of Industrial Engineering (n=34). Source: Primary survey data, 2025.

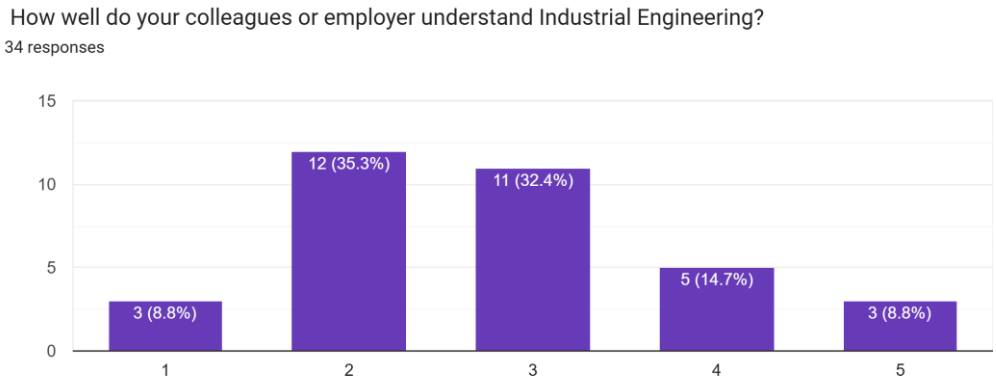

Figure 4. Employer/colleague understanding of Industrial Engineering (n=34). Source: Primary survey data, 2025.

As illustrated in Table 4.5 and Figure 4, more than 44% of respondents (n=15) rate employer understanding at 2 or below. This confirms the study's core research problem: nearly half of GMIT IE graduates operate in organizational environments where their disciplinary identity is poorly understood. The implications of this finding are further discussed in Section 5.4.

Interestingly, this distribution is not strictly bimodal (low understanding vs. high understanding) there is a large cluster in the middle: 32.4% of respondents answer 3 (somewhat) when asked about employer understanding. This would imply that many graduates work somewhere that understands IE to a degree--maybe they know it as a technical business crossover discipline, but may lack specificity on what exactly IE covers and how. This 'partial recognition' category is strategically important: these employers are closest to becoming fully IE-aware and may be converted with relatively modest engagement effort, as opposed to employers in the 'very poorly understood' category who require foundational education about the discipline.

The employer awareness finding also interacts meaningfully with the salary data (Figure 3). Despite below-midpoint awareness scores, graduates earn substantially above-average salaries. This apparent paradox resolves when one recognizes that employers are compensating graduates for their demonstrated competency performance—project coordination ability, analytical capability, problem-solving effectiveness—independently of understanding the disciplinary framework behind these competencies. The salary premium confirms functional recognition; the awareness score reveals the absence of disciplinary recognition. Both are real, and both matter: functional recognition drives compensation, but disciplinary recognition drives role definition, career pathway development, and the formal institutionalization of IE as a profession.

Despite this low awareness score, graduates maintain strong positive attitudes toward the program. Figure 5 shows that 52.9% would recommend studying IE to others, 41.2% responded 'Maybe,' and only 5.9% would not recommend—a combined positive-to-neutral rate of 94.1%. Figure 6 indicates that 64.7% of graduates believe they could probably or definitely perform their current job without an IE education (Yes: 26.5%; Probably yes: 38.2%), reflecting IE's role as a competitive advantage rather than a strict prerequisite in many current roles.

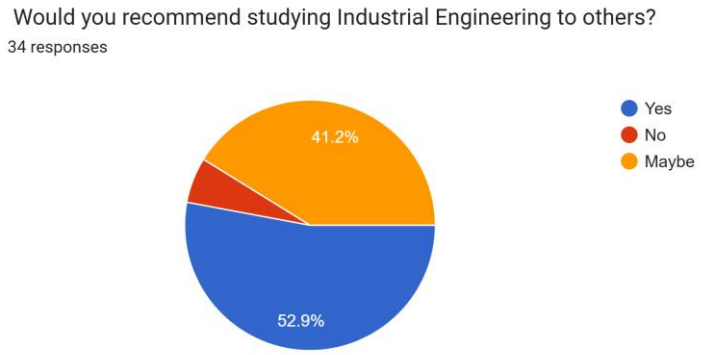

Figure 5. Graduate recommendation of IE program to others (n=34). Source: Primary survey data, 2025.

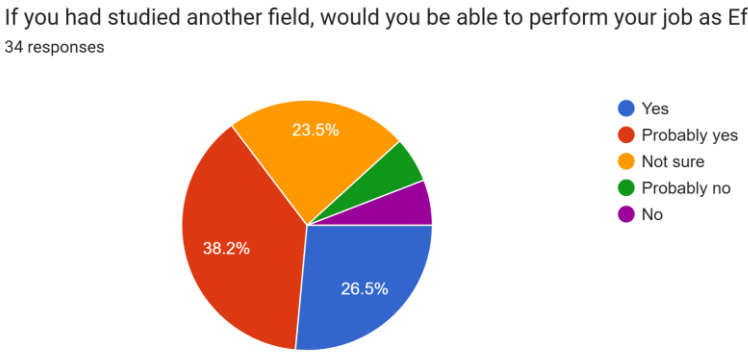

Figure 6. Perceived ability to perform current job without IE education (n=34). Source: Primary survey data, 2025.

4.4 Skill Utilization and Alignment Analysis

4.4.1 University vs. Workplace Skill Utilization

Table 4.6 shows the difference in average levels of skill use for 13 skills between university and work settings (5-point scale; responses range from n = 28–33 per skill due to students not answering all questions). Positive numbers indicate a shortfall (greater use at Work > University) and negative numbers the opposite. Figure 2 provides visual comparison of all 13 competencies.

Skill Competency	Univ. Mean	Work Mean	Gap (W−U)	Priority
Data Analysis (Excel, Python, etc.)	2.90	3.84	+0.94	Critical ↑
Problem-solving	3.69	4.22	+0.53	High ↑
Communication	3.81	4.31	+0.50	High ↑
Process Optimization	2.97	3.31	+0.35	Moderate ↑
Critical thinking	3.97	4.31	+0.34	Moderate ↑
Teamwork	3.97	4.25	+0.28	Moderate ↑
Operations Management	3.16	3.44	+0.28	Moderate ↑
Leadership	3.57	3.81	+0.25	Low ↑
Time management	4.00	4.16	+0.16	Low ↑
Adaptability	4.10	4.19	+0.09	Minimal →
Quality Management	2.93	2.88	−0.06	Aligned →
Project Management	3.77	3.66	−0.12	Slight ↓

Supply Chain Management	3.10	2.72	−0.38	Curriculum ↓	

Table 4.6. Skill utilization comparison: university vs. workplace (mean scores, 1–5; n=28–33). Source: Primary survey data, 2025.

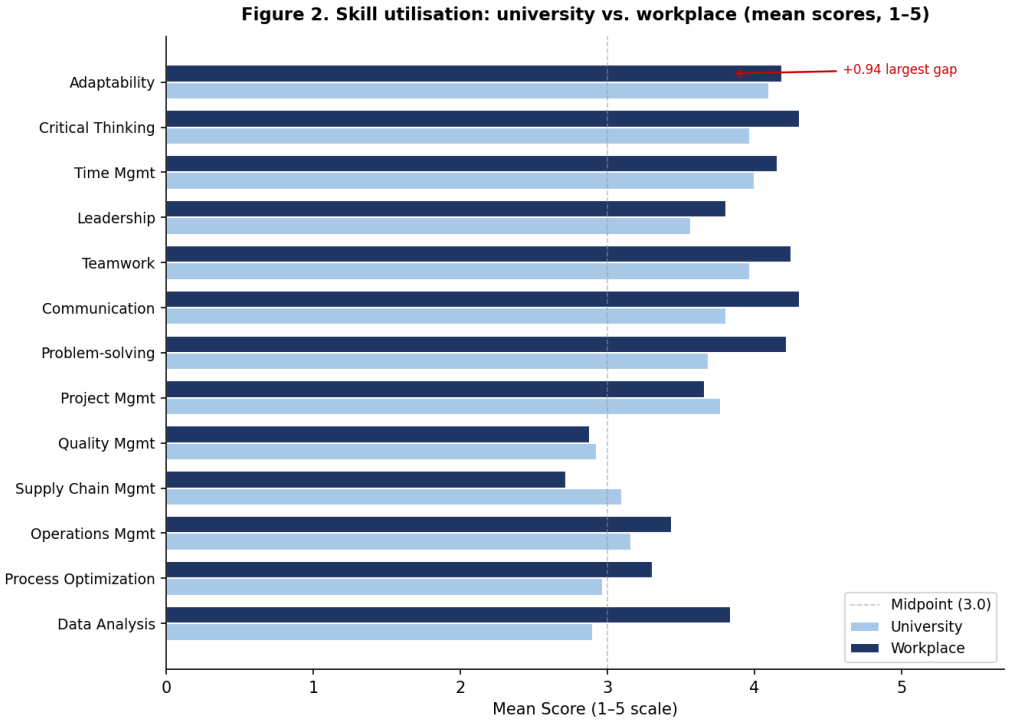

Figure 2. Skill utilization: university vs. workplace mean scores (1–5 scale). Source: Primary survey data, 2025.

As shown in Table 4.6 and Figure 2, the most critical finding is the Data Analysis gap of +0.94—the largest mismatch across all competencies. Graduates enter the workforce with a university preparation mean of 2.90 (below midpoint), yet the workplace demands a mean of 3.84. This is directly relevant to a core program learning outcome stated in the GMIT Module Handbook: graduates should be able to 'apply information science and analyze big data for solving industrial engineering problems' [21]. The gap indicates that this stated objective is not yet being met at the level industry requires.

Problem-solving (+0.53) and Communication (+0.50) also show substantial positive gaps. The GMIT program explicitly develops communication skills through modules including ENGL101 (Technical English), INCC101 (Intercultural Communication and Competence), and STWR401 (Scientific Writing) [21]; yet workplace demands remain higher, reflecting the richer complexity of authentic professional communication that no curriculum can fully replicate. The negative gap for Supply Chain Management (−0.38) reflects that early-career graduates in Mining and Construction tend to perform project

coordination and technical functions more frequently than formal supply chain management—consistent with the specific roles documented in Table 4.8 (Section 4.5).

4.4.2 Perceived Gaps in University Preparation

Graduates identified curriculum areas they considered insufficient compared to workplace requirements (multiple selections permitted). Table 4.7 presents the results; Figure 7 shows the university preparation self-assessment distribution.

Gap Area Identified	n	% of Respondents
Industry-specific knowledge	19	55.9%
Software and technical tools	14	41.2%
Data analysis skills	14	41.2%
Soft skills	9	26.5%
Practical training / internships	7	20.6%
Project management	5	14.7%
No major gaps	3	8.8%

Table 4.7. Perceived insufficient areas in university preparation (multiple selections; n=34). Source: Primary survey data, 2025.

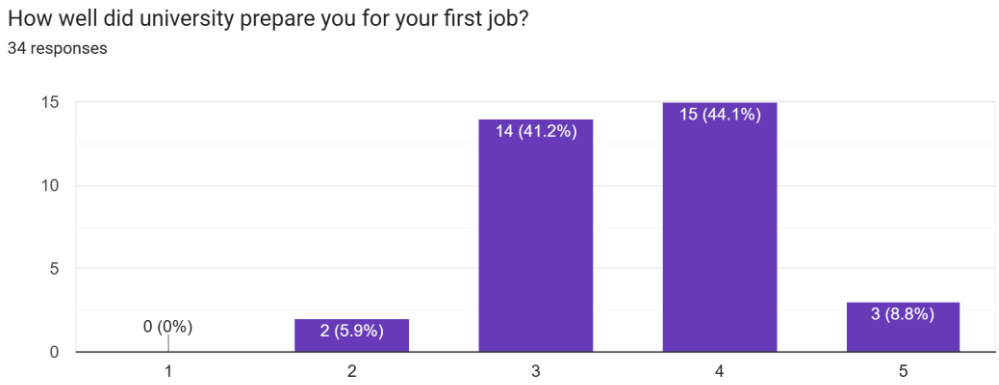

Figure 7. University preparation for first job, self-assessment (1=very poor, 5=very good; n=34). Source: Primary survey data, 2025.

As shown in Table 4.7, industry-specific knowledge was the most cited gap (55.9%). The convergence of Table 4.7 with Table 4.6's skill gap analysis independently confirms data analytics as a critical curriculum priority. Figure 7 shows the overall preparation assessment: 44.1% rated preparation at 4 out of 5 and 8.8% at 5/5, suggesting

moderate-to-good general preparation. However, the combination with the gap data in Table 4.6 and Table 4.7 indicates that good general preparation coexists with specific, actionable deficits in applied digital skills and industry context.

The 8.8% of graduates reporting no major gaps (Table 4.7) deserves specific comment. These are graduates who feel well-prepared across all competency dimensions—likely concentrated among those in roles with the highest alignment between IE training and job requirements (high job relevance scores in Table 4.4, Rows 4–5). The absence of significant numbers in this category reinforces the conclusion that curriculum-industry alignment gaps are the norm rather than the exception for the current program, and that systematic improvement is needed rather than targeted adjustment for specific subgroups.

Figure 7 provides important context for interpreting the gaps identified in Table 4.7. The distribution shows that 44.1% of graduates rated university preparation for their first job at 4 out of 5, and a further 8.8% at 5 out of 5—suggesting that general preparation is experienced as good to excellent by a majority of graduates. This confirms that the gaps in Table 4.7 are not evidence of broadly poor preparation but of specific, identifiable deficits in applied digital skills and operational industry knowledge that coexist alongside generally effective technical and professional development. This distinction is important for curriculum design: it argues for targeted enhancement of specific modules rather than comprehensive program restructuring.

4.5 Professional Roles and Responsibilities

Project Management was the most frequently reported primary job function (n=8, 27.6%), followed by Operations and Production (n=4, 13.8%) and Data Analysis, Maintenance, and Supply Chain roles (each n=3, 10.3%). This project management dominance directly reflects the Mining and Construction sector concentration shown in Table 4.2 (Section 4.2.2). Table 4.8 presents the daily responsibilities of employed graduates.

Responsibility	n	% of Respondents
Planning and scheduling	19	59.4%
Improving efficiency (time/cost)	18	56.2%
Managing/coordinating projects	18	56.2%
Data analysis and reporting	18	56.2%
Team coordination	18	56.2%
Supporting decision-making	15	46.9%

Increasing productivity	12	37.5%
Improving quality	11	34.4%
Reducing waste	7	21.9%
Improving safety	6	18.8%

Table 4.8. Distribution of daily responsibilities among employed GMIT IE graduates (multiple selections; n=32). Source: Primary survey data, 2025.

The high simultaneous prevalence of project coordination, data analysis, efficiency improvement, and team coordination among the same respondents confirms that GMIT IE graduates perform multi-dimensional, cross-functional roles consistent with the IE core competency model [1]. These responsibilities align directly with the learning outcomes of INDE301 (Project Management), INDE303 (Operations Management), INDE402 (Operations Research), and INDE405 (Quality Management) as defined in the GMIT Module Handbook [21].

4.6 RQ3 – Value Creation and Organizational Impact

Graduates rated two value creation dimensions on a five-point scale (1=not at all; 5=very high contribution). Figure 8 shows the distribution for measurable improvements contributed in their work, and Figure 9 shows responses for the statement ‘My IE background helps me create value in my job.’

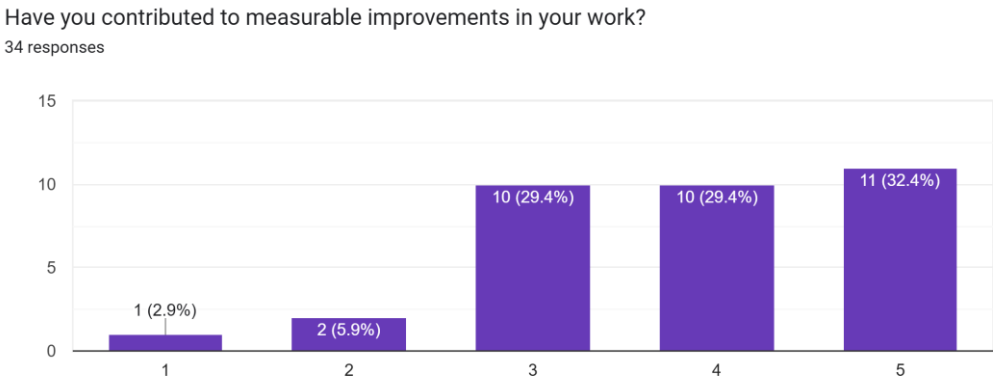

Figure 8. Self-assessed contribution to measurable improvements in work (1–5 scale; n=34). Source: Primary survey data, 2025.

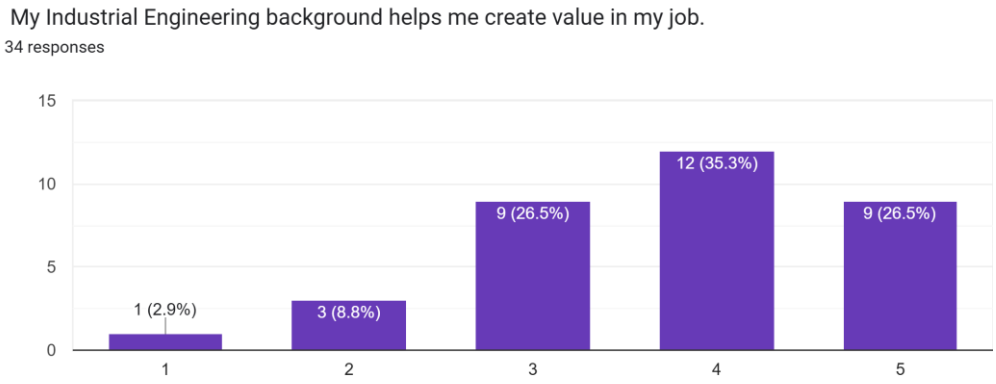

Figure 9. IE background helps create value in current job (1–5 scale; n=34). Source: Primary survey data, 2025.

As shown in Figure 8, 61.8% of respondents scored 4 or 5 on measurable improvement contribution (mean=3.85), indicating the majority perceive themselves as high-value organizational contributors. As shown in Figure 9, 61.8% scored 4 or 5 on the IE background value statement (mean=3.76). The three interview impact cases documented in Section 4.7.3 provide the qualitative corroboration for these quantitative self-assessments.

The cross-validation between Figures 8 and 9 is analytically important. Figure 8 asks whether graduates have contributed to measurable improvements—an objective question about outcomes. Figure 9 asks whether their IE background helps them create value—a question about mechanism attribution. The fact that both distributions are nearly identical (61.8% scoring 4–5 on both items) indicates strong internal consistency in how graduates assess their organizational impact: those who are contributing measurably tend also to attribute this contribution to their IE training, and vice versa. This correlation supports the interpretation that IE education is not merely associated with employment success but is perceived as a direct mechanism of value creation by the graduates who apply it.

The perceived contribution to national economic development (mean 3.30/5, n=33) provides a macro-level perspective on the cumulative impact of the GMIT IE program. The most commonly cited contribution mechanism is Mining sector efficiency—reflecting the sector concentration documented in Table 4.2. However, the diversity of contribution pathways cited—including IT development, sustainability, education, and operational efficiency across non-mining sectors—indicates that GMIT IE graduates perceive their work as contributing to Mongolia's broader economic development, not solely to its

extractive industry base. As cohort sizes increase and careers mature, this perceived contribution will likely grow in both scope and specificity.

4.7 Qualitative Findings: In-Depth Interview Analysis

4.7.1 Interview Design, Sample and Limitations

The qualitative component was designed to explain the mechanisms behind the quantitative patterns in Sections 4.2–4.6 and to generate actionable evidence grounded in real career experiences. The original plan targeted six participants; three were completed due to scheduling constraints. The three participants—Orgilsaikhan Munkhbaatar (2021, mining/EPCM, Oman), Oyungerel Ganbaatar (2025, telecommunications, Mongolia), and Zanabazar Altangerel (2022, heavy machinery/mining, Mongolia)—represent distinct sectors, career stages, and cohorts. Table 4.9 summarizes their profiles. The absence of employer interviews reduces RQ2 depth, as noted in Section 3.4.

Participant	Grad.	Current Role	Sector	Location
Orgilsaikhan Munkhbaatar	2021	Senior Field Engineer, Lycopodium EPCM	Mining/Construction	Oman
Oyungerel Ganbaatar	2025	Assurance Management Specialist, Huawei	Telecommunications	Mongolia
Zanabazar Altangerel	2022	Applied Failure Analysis Analyst, Barloworld	Heavy Machinery/Mining	Mongolia

Table 4.9. Interview participant profiles. Source: Primary interview data, 2025.

4.7.2 Career Narratives: From Classroom to Industry

Career Narrative 1: Orgilsaikhan Munkhbaatar – A Systematically Built Multi-Sector Career

Orgilsaikhan Munkhbaatar represents one of the most advanced and internationally recognized career trajectories among GMIT's IE graduates. His professional journey through six positions in six years, from QA Engineer supporting a domestic construction project to Senior Field Engineer supporting an international EPCM project in Oman, is unique not because of one moment of success or clarity, but because of his intentional and progressive focus on gaining competencies, which he directly relates to his IE

training.

He started his career as Quality Assurance Engineer with Khan Altai Resources, a mining and construction company based in Mongolia. Because of the small size of the company, there were limited resources with specialized QA knowledge, so he found himself inspecting structural, mechanical, piping, and civil/architectural work. He also had to learn how to read ITPs (inspection and test plans), construction checklists, and understand international standards for construction quickly. From this position, he gained 'a map of how construction actually works.' He refers to this broad, systems level understanding of how construction progresses, how it is dependent on different entities working together, and what goes into ensuring projects are done correctly.

"Every role I had was useful and meaningful in its own way, and each one added something important to my foundation. My first QA role gave me a strong technical construction base. Operations taught me how a plant really performs. Design taught me calculations, layouts, and engineering thinking. EPCM project roles taught me communication, contracts, procurement, and stakeholder management." **— Orgilsaikhan Munkhbaatar**

After the construction project phase, Orgilsaikhan transitioned to gold metallurgy operations, seeking to understand mineral processing from the production side. This transition demonstrated a characteristic pattern of IE-educated professionals: the capacity and willingness to move laterally into adjacent technical domains to build a broader operational understanding. During this role, he made a contribution that directly exemplifies the organizational value of IE education:

> *"I had the chance to help develop the company's 2023 business plan for the processing department, including what could be processed, when it could be processed, and what cashflow scenarios that would create. That taught me that industrial engineering is valuable not only technically, but also from a business and planning perspective."* **— Orgilsaikhan Munkhbaatar**

Subsequent roles at Soyolon Engineering (detailed design of tailings thickeners), Worley EPCM at Oyu Tolgoi underground expansion (surface conveyors and brownfield integration into a 40 Mtpa concentrator), Khurgatai Khairkhan (temporary facilities and concentrator contractor selection), and his current role with Lycopodium EPCM in Oman document a career built on the systematic accumulation of increasingly complex engineering and project management competencies. His current international appointment—obtained through a professional referral from a former Oyu Tolgoi

colleague who 'saw potential in me'—represents the network and reputation payoff of sustained high-performance delivery across successive roles.

Career Narrative 2: Oyungerel Ganbaatar – Operational Execution to Analytical Leadership

Oyungerel Ganbaatar's career at Huawei Mongolia documents a distinct but equally instructive career pattern: the transition from operational execution roles—focused on inventory control, logistics efficiency, and supply availability—to analytical leadership roles involving KPI monitoring, service quality assessment, and cross-functional performance improvement. This trajectory reflects the upward mobility potential of IE graduates in non-IE-branded organizations.

Beginning as a Spare Parts Warehouse Specialist, Oyungerel was responsible for managing the inventory of critical Huawei network components, ensuring timely availability, and minimizing stock discrepancies. She applied IE process analysis methods to improve warehouse flow and reduce inventory inefficiencies—functions that, while not labeled as Industrial Engineering by Huawei, are substantively identical to classic IE warehouse optimization work.

> *"The key turning point was moving from warehouse operations into assurance management. In the warehouse role, I focused on execution and efficiency, but in assurance management, I became involved in performance evaluation, KPI tracking, and service quality improvement. This transition helped me see the broader system and understand how operational decisions impact overall business performance."* **— Oyungerel Ganbaatar**

In her current Assurance Management Specialist role, Oyungerel's responsibilities have expanded to encompass service performance monitoring, KPI analysis, compliance with service standards, cross-departmental coordination, and continuous improvement initiatives. She attributes her career advancement directly to the systems perspective developed through IE education:

> *"My Industrial Engineering background has been fundamental in shaping how I approach problems. In warehouse operations, I applied IE principles to improve inventory flow and reduce inefficiencies. In assurance management, I use them to analyze KPIs, identify bottlenecks, and improve overall service performance. The ability to see the entire system rather than isolated tasks has been especially valuable."* **— Oyungerel Ganbaatar**

Oyungerel's trajectory illustrates a career pattern increasingly common among GMIT IE graduates: entry-level placement in operational roles that initially appear tangential to IE practice, followed by upward transition into analytical and strategic functions as the graduate's IE-derived analytical capabilities become recognized and valued by their employer. This pattern suggests that the 'Embedded IE' phenomenon has a dynamic career dimension—graduates who enter in operational roles may gradually develop into more formally IE-aligned analytical functions as their IE capabilities become visible over time.

Career Narrative 3: Zanabazar Altangerel – Disciplined Technical Specialization from an IE Base

Zanabazar Altangerel's career at Barloworld Mongolia—the authorized Caterpillar mining machinery dealer for Mongolia—represents a third distinct career pattern: the deliberate pivot from a generalist IE foundation into deep technical specialization in a domain (heavy machinery failure analysis) that is conventionally associated with Mechanical Engineering. His career progression from New Product Introduction Coordinator to Warranty Specialist to Applied Failure Analysis (AFA) Analyst documents how an IE graduate can successfully enter and advance in a highly technical specialization role by leveraging the systems-level perspective that IE education develops.

As a New Product Introduction Coordinator, Zanabazar learned Caterpillar's product specifications, operational advantages, and the technical requirements for integrating new mining machinery into customer operations. This broad understanding of the product-customer-dealer system positioned him well for the Warranty Specialist role, where he was responsible for administering warranty processes for all newly sold machines, assessing repair cost attribution, and initiating claims against the manufacturer for defects. This role required a combination of technical knowledge, process management, and multi-stakeholder communication—a combination that Zanabazar describes as being directly supported by his IE training.

> *"Industrial Engineers should see the bigger picture of all project or tasks. Then I showed to the company that I can see the different perspectives or I have huge scope of sight. Seeing a bigger picture and different perspectives really pushed my career path."* **— Zanabazar Altangerel**

In his current AFA Analyst role, Zanabazar conducts post-failure inspections on Caterpillar machinery, determines the root cause of failures at a technical level, and makes cost attribution decisions among three parties: the customer, the dealer

(Barloworld Mongolia), and the manufacturer (Caterpillar). He describes this as requiring simultaneous analysis from three organizational perspectives:

> *"My current position as AFA analyst should see from three different sides: from customer, from dealer (Barloworld Mongolia LLC), and from manufacturer (CAT). That is exactly what Industrial Engineering teaches you—to see the whole system."* **— Zanabazar Altangerel**

Zanabazar is candid about the most significant challenge he has faced, which he identifies not as technical knowledge but as communication: managing high-stakes client interactions with composure and professional presence. His description of how he addressed this challenge—through deliberate practice and iterative learning from mistakes—reflects the same growth-oriented approach to competency development that characterizes all three interview participants.

4.7.3 Value Creation: Impact Case Examples

Impact Case 1 – Production Scenario Modeling and Business Planning (Orgilsaikhan Munkhbaatar, 2023)

During his role as a Gold Metallurgist, Orgilsaikhan contributed to developing the processing department's 2023 business plan. This involved production scenario analysis—determining what material volumes could be processed under different equipment configurations, scheduling these scenarios across the annual calendar, and projecting the cashflow implications of each scenario for senior management decision-making. This represents a direct application of production planning, operations analysis, and financial modeling competencies that are central to IE education—delivered in a context (operating gold plant business planning) where formal IE recognition did not exist but where IE methods were precisely applicable. The plan was used to guide the company's strategic decisions about plant readiness and resource allocation.

Impact Case 2 – KPI Framework Development and Service Quality Improvement (Oyungerel Ganbaatar, 2024–2025)

In her Assurance Management Specialist role at Huawei Mongolia, Oyungerel has developed and implemented systematic KPI monitoring frameworks for service quality tracking across the company's network operations. These frameworks identify performance deviations, flag systemic bottlenecks in service delivery processes, and generate analytical reports that inform technical and operational team decision-making. The impact includes improved detection speed for service quality issues and enhanced cross-departmental coordination for service restoration and improvement. This contribution translates IE process improvement and analytical methods into a

telecommunications context where the formal category of Industrial Engineering does not exist but where the methods are directly applicable and impactful.

Impact Case 3 – Root Cause Analysis and Cost Attribution in Mining Equipment (Zanabazar Altangerel, 2023–2025)

As an Applied Failure Analysis Analyst, Zanabazar conducts technically rigorous post-failure inspections of Caterpillar mining machinery—equipment with individual replacement costs potentially exceeding USD 1–5 million for major components. Each AFA report determines the root cause of failure at the component or system level and recommends cost attribution among customer, dealer, and manufacturer. Incorrect attribution would either impose unjustified financial costs on one party or allow another party to avoid responsibility for a genuine defect. The analytical rigor, multi-perspective systems approach, and structured decision-making that characterize Zanabazar's AFA practice are directly attributable to his IE foundation. In this context, the financial stakes of each correct or incorrect attribution decision make the competency contribution directly measurable in monetary terms.

4.7.4 The Systems Thinking Advantage: A Cross-Case Theme

Thematic analysis of all three interview transcripts identifies systems thinking—the capacity to analyze complex situations by understanding the relationships among system components rather than optimizing individual elements in isolation—as the dominant, most consistently articulated, and most distinctive outcome of GMIT's IE education. All three participants independently and explicitly identify this capacity as the most valuable element of their IE preparation, deploying it as the primary explanatory factor for their professional advancement.

Orgilsaikhan articulates it as the capacity for fast learning across domains: 'Industrial engineering made it easier to learn quickly across QA, operations, design, planning, business, and project delivery... It supported my fast learning because I already had a broad base.' The breadth of his career—crossing QA, metallurgy, design, EPCM, and field engineering—is only coherent in the context of a systems-level foundation that enables rapid, principled learning in each new domain.

Oyungerel articulates it as the capacity to see beyond operational tasks to systemic drivers: 'The ability to see the entire system rather than isolated tasks has been especially valuable.' Her transition from warehouse operations to assurance management—from execution to analysis—was explicitly enabled by her capacity to reframe individual operational observations within a systemic performance framework.

Zanabazar articulates it most concisely as multi-perspective analytical breadth: 'Industrial Engineers should see the bigger picture... Seeing a bigger picture and different perspectives really pushed my career path.' His simultaneous consideration of customer, dealer, and manufacturer perspectives in AFA decisions is a direct operational expression of systems thinking applied to a specific professional context.

The convergence of this theme across three graduates working in entirely different sectors—international mining EPCM in Oman, telecommunications at a major global company, and heavy machinery at a specialized dealer—provides strong qualitative evidence that systems thinking is not sector-specific but is a genuinely transferable competency outcome of GMIT's IE program. This finding supports the study's core argument: the functional value of GMIT IE graduates derives primarily from their systems-level analytical capacity, which creates competitive advantage across diverse professional contexts regardless of whether the employer formally recognizes or labels this competency as Industrial Engineering.

4.7.5 Employer Awareness: Graduates' Workplace Perspective

The interview evidence provides nuanced, first-hand perspectives on RQ2 (employer awareness) that complement and contextualize the quantitative survey findings. Across all three cases, a consistent pattern is observed: employers recognize and value the functional contributions of GMIT IE graduates—their analytical approach, their capacity to see multiple perspectives, their systematic problem-solving—without necessarily understanding that these competencies derive from a specific disciplinary training in Industrial Engineering.

Orgilsaikhan's experience in international EPCM organizations (Worley, Lycopodium) suggests that in globally operating engineering companies, competency-based recognition may partially substitute for disciplinary label recognition. His current international appointment—secured through professional referral based on demonstrated performance rather than disciplinary credentials—indicates that in high-performance international project environments, what engineers do is more visible than what their degree is called.

Zanabazar identifies the communication dimension of awareness as the practical challenge he encounters most directly: 'The biggest challenge I faced in building my career is communication skill... when I am going to meet one of my customer I got nervous and all my moods, emotion come out on my face.' This challenge is not about employer awareness of IE per se, but about the graduate's capacity to communicate their professional value proposition clearly and confidently in high-stakes interactions. His

resolution—'practice makes perfect, and learn from your mistakes'—reflects a self-directed learning approach that partially compensates for the absence of institutional support in building professional credibility.

Oyungerel's account at Huawei Mongolia confirms the 'functional invisibility' dimension of the awareness gap: IE methods are applied and valued within her organization's quality and operations management functions, but under the organizational language of 'assurance management' rather than 'Industrial Engineering.' This linguistic gap—between what IE methods are called within the organization and what they are called within the discipline—perpetuates the awareness deficit even when the underlying competencies are actively appreciated.

5 Discussion

This chapter interprets the quantitative and qualitative findings of Chapter 4 in relation to the research questions, the theoretical frameworks established in Chapter 2, and the study's core argument. The discussion is organized around the eight thematic dimensions that collectively address RQ1–RQ3 while situating the findings within the broader international context of IE education in developing economies.

5.1 Mining Sector Dominance and Structural Employment Patterns

The finding that 38.7% of employed GMIT IE graduates work in the Mining sector is the single most defining characteristic of the graduate employment landscape and demands interpretation at both the structural and disciplinary levels. At the structural level, Mongolia's economic dependence on mineral extraction is the most fundamental contextual factor shaping every aspect of technical graduate employment in the country. Mining and quarrying contribute 23–25% of GDP and over 80% of export revenue [13]; the World Bank characterizes Mongolia as one of the most mining-dependent economies in the world [14]. In this context, the concentration of technically trained graduates in the most economically dominant sector is entirely expected and structurally rational.

At the disciplinary level, however, this concentration carries specific implications. Mining operations—particularly large-scale open-pit and underground metallic ore operations—are among the most operationally complex industrial environments in existence, requiring simultaneous management of heavy equipment fleets, multi-stage processing circuits, complex logistics networks, large-scale project execution programs, and multi-faceted quality and safety systems. These are precisely the system-level operational challenges that IE is designed to address. This confirms that the alignment between

GMIT IE graduate competencies and Mongolia's dominant industrial employment context is not coincidental but structurally appropriate.

The interview evidence reinforces this finding powerfully: Orgilsaikhan's career spans QA, metallurgy, detailed design, and EPCM project delivery across multiple mining sites; Zanabazar contributes technical analysis for Caterpillar mining equipment used across Mongolia's mines; even Oyungerel's telecommunications work supports the network infrastructure that increasingly connects Mongolia's geographically dispersed mining operations. The Mining sector is not merely the most common employer—it is the operational epicenter around which a significant portion of the GMIT IE graduate employment ecosystem is organized.

The simultaneous presence of graduates in IT, sustainability consulting, tourism, and international project management in Oman confirms that the Mining-dominated sectoral distribution is not a constraint on graduate versatility but a reflection of current market structure. As Mongolia's economy diversifies—a trajectory supported by the current government's development plans—the graduate footprint is expected to expand. This confirms Blom and Saeki's developmental economy pattern: engineering graduate sector concentration in extractive industries during early industrialization phases, followed by diversification as industrial complexity increases [19].

5.2 Rapid Labor Market Absorption and Graduate Readiness

The finding that 64.7% of GMIT IE graduates enter employment within three months of graduation—including 20.6% who are employed before graduation—establishes a compelling prima facie case for the labor market relevance of the program. By Yorke's definition [15], these graduates are demonstrably employable: they possess achievements, skills, and personal attributes that make them likely to gain employment quickly. By Schomburg's GTS benchmark [4,11], the 88.2% employment rate within six months substantially exceeds the 60–70% threshold for strong program performance.

This rapid absorption into the workforce is particularly significant given the low employer awareness of IE as a discipline (mean 2.79/5). It demonstrates that employers are hiring GMIT IE graduates not because they recognize and seek out 'Industrial Engineers,' but because they recognize the specific competencies these graduates demonstrate—analytical thinking, project coordination capacity, systems perspective, and communication skills—and can use them effectively in the roles they are filling. This competency-driven recognition, independent of disciplinary label awareness, explains the apparent paradox of high employment rates coexisting with low employer IE

awareness: the graduates are getting hired for what they can do, not for what they are called.

The implication for future employer engagement strategy is important: GMIT's communication to employers should lead with graduate competencies and demonstrated impact—not with the disciplinary label 'Industrial Engineering.' Once employers have experienced the value of GMIT IE graduates through competency-based recruitment, the disciplinary awareness building can follow as a second step that gives formal recognition to a functional experience employers have already found valuable.

5.3 The 'Embedded IE' Phenomenon

The 'Embedded IE' phenomenon—the systematic performance of IE functions by graduates in roles not formally classified as Industrial Engineering positions—is this study's most theoretically significant finding and has implications that extend beyond GMIT to the broader question of IE's professional development in developing economies.

Empirically, the phenomenon is evidenced through three convergent data sources. First, the mean job relevance score of 3.30 indicates that the majority of graduates perceive their work as moderately related to IE without identifying it as directly IE-aligned. Second, the responsibility profile in Table 4.8 shows that 56.2% of graduates simultaneously engage in project coordination, data analysis, efficiency improvement, and team coordination—a responsibility combination that is functionally equivalent to a classic IE operational role. Third, the interview narratives confirm that all three participants perform IE methods (production planning, process optimization, KPI analysis, failure mode analysis) under professional titles (Gold Metallurgist, Assurance Manager, Failure Analysis Analyst) that carry no explicit IE designation.

Theoretically, the phenomenon is interpretable through Teichler's concept of horizontal occupational mismatch [17]. However, the conventional negative connotation of 'mismatch'—implying underemployment or misallocation of graduate competencies—is not appropriate here. GMIT IE graduates in 'Embedded IE' roles are not performing below their capability level; they are performing precisely at the level their education prepared them for, in organizations that have created the functional need for IE methods without yet having developed the formal organizational vocabulary to recognize those methods as 'Industrial Engineering.'

The policy implication is consequential: closing the gap between the functional embeddedness of IE and its institutional recognition requires not that more graduates be produced, but that the organizational contexts in which they already operate be made

aware of the disciplinary label that accurately describes what they are doing. This is an employer awareness challenge, not a graduate supply challenge.

5.4 Employer Awareness as a Structural Barrier

The employer awareness mean of 2.79—placing the average workplace understanding of IE below the scale midpoint—is the most strategically consequential finding of this study and demands direct, decisive interpretation: employer awareness of Industrial Engineering in Mongolia is structurally insufficient to support the full professional realization of GMIT IE graduate competencies. This is not a marginal deficit. The fact that 45.5% of graduates (n=15 of 33) rate employer understanding at 2 or below means that nearly half of GMIT IE graduates are working in organizational environments where the professional identity behind their competencies is unknown or poorly understood by the people they work with.

This structural deficit operates through three distinct mechanisms of impact. First, at the role definition level: employers who do not understand what IE means cannot create formal IE job categories, write IE-specific job descriptions, or develop structured IE career pathways within their organizations. GMIT IE graduates therefore enter undefined organizational niches rather than recognized professional roles, which constrains their ability to negotiate appropriate responsibilities, resources, and recognition from the outset.

Second, at the organizational learning level: when employers do not recognize IE as the source of the analytical and optimization methods their graduates are applying, the institutional knowledge that 'hiring GMIT IE graduates produces X type of value' cannot develop within the organization. Each new IE graduate hired must prove their value individually and from scratch, without benefit of accumulated institutional recognition. This is an enormously inefficient learning process for both the graduate and the employer.

Third, at the societal level: the absence of employer awareness perpetuates the absence of formal IE role categories in Mongolia's occupational classification system, which in turn makes it impossible to collect labor market statistics on IE employment, which in turn prevents evidence-based policy development for engineering workforce planning. The ILO confirms that professional recognition is a structural prerequisite for graduates to fully leverage their disciplinary training in the labor market [20]—and GMIT's IE program currently operates without that structural prerequisite.

This confirms that building employer awareness is not a secondary communication concern but a first-order strategic institutional priority. The recommendations in Chapter

6 address this through specific, actionable mechanisms for employer engagement, professional network development, and occupational classification advocacy.

5.5 Skill Gaps and Curriculum Implications

The skill gap analysis yields findings of both analytical clarity and practical urgency. The data analytics gap of +0.94—the largest mismatch in the study, representing nearly one full scale point on a five-point scale—constitutes unambiguous evidence of a critical curriculum deficiency. When this quantitative finding is triangulated with 43.8% of respondents independently identifying Data analysis skills and Software and technical tools as insufficient preparation areas, and with the interview evidence (Orgilsaikhan noting that 'the lack of Excel, business software was a major drawback in the first year of employment'), the evidence for immediate curriculum intervention is overwhelming.

The significance of this gap must be understood in context. Data analytics in the Industrial Engineering sense does not mean advanced machine learning or artificial intelligence—it means the foundational capacity to extract operational data from business systems, clean and organize it, apply statistical analysis, create visualizations, and communicate data-driven recommendations to decision-makers. In the Mongolian mining sector—where production management systems, maintenance tracking software, and logistics platforms generate continuous operational data—this capacity is not a specialist skill but a baseline professional requirement. GMIT IE graduates who enter the workforce without proficiency in Python for data analysis, Power BI for visualization, or SQL for database queries are operating at a material disadvantage in an environment where these tools are increasingly standard.

The industry-specific knowledge gap (59.4% of graduates) presents a more complex curriculum challenge because industry-specific knowledge cannot be effectively developed through classroom instruction alone. It requires sustained, structured exposure to real operational environments—through internships, site visits, industry-mentored projects, and capstone assignments developed in partnership with actual companies. The fact that only 21.9% of graduates identify Practical training and internships as an insufficient area may seem to contradict the industry knowledge gap finding, but is more likely explained by the limited availability of structured IE-relevant internship opportunities in the current market: graduates report the internship experience as adequate (when they have had one) but do not have sufficient access to internships to address the underlying industry knowledge deficit comprehensively.

The positive gaps in Problem-solving (+0.53) and Communication (+0.50) confirm the global pattern documented by Suarta et al. [16] and the WEF [8]: soft skills are

systematically underweighted in formal academic assessment relative to their actual workplace importance. GMIT appears to develop these competencies at above-midpoint levels—university means of 3.69 and 3.81—yet the workplace demands are 4.22 and 4.31. This gap is unlikely to be fully closeable through curriculum design alone; it reflects the inherently richer, more complex communication and problem-solving demands of authentic professional practice. The most effective curriculum response is to maximize the intensity and authenticity of practice-oriented learning opportunities within the degree program.

5.6 Value Creation: GMIT IE Graduates as Organizational Assets

The value creation evidence assembled in this study—quantitative impact scores and qualitative impact cases—presents a consistent picture of GMIT IE graduates as active, contributing organizational assets rather than passive employees learning their trade. The measurable improvement mean of 3.85 and IE value mean of 3.76 indicate that the majority of graduates perceive their IE training as directly enabling their organizational contributions. The three interview impact cases document this concretely: production planning that informed a mining company's annual business strategy; KPI system development that improved telecommunications network quality monitoring; and failure mode analysis that made financially consequential warranty attribution decisions more accurate and defensible.

The responsibility data (Table 4.8) reinforces this finding structurally: the high prevalence of planning and scheduling (59.4%), efficiency improvement (56.2%), project coordination (56.2%), and data analysis (56.2%) as simultaneous responsibilities confirms that GMIT IE graduates are performing multi-dimensional, high-complexity roles that require and deploy the full breadth of their IE education. These are not peripheral functions—they are core organizational operations. The graduates occupying these roles are not merely present in their organizations; they are functionally load-bearing elements of their organizations' operational systems.

Khosrow-Pour's analysis confirms that engineers with process optimization and analytical competencies are disproportionately represented among high-value contributors in organizations undergoing operational transformation [9]. Mongolia's mining sector is currently undergoing precisely such a transformation—from labor-intensive, empirically managed operations toward data-driven, optimization-oriented management systems. GMIT IE graduates are positioned exactly at the intersection of the competencies required by this transition and the sector in which it is occurring.

5.7 Future Opportunities: Strategic Pathways for GMIT IE Graduates

The combined evidence of this study defines four strategic pathways for the future development of GMIT IE graduates and the IE program, each grounded in specific findings rather than general aspiration.

The first and most immediately actionable pathway is the deepening of mining sector specialization. Mongolia's mining industry is entering a phase of technological intensification—driven by increasing ore body complexity, automation of equipment fleets, and digitalization of operational management systems—that will systematically increase demand for engineers capable of integrating data analytics with production planning, maintenance optimization, and process improvement. This is core IE territory, and GMIT is uniquely positioned to develop the sector-specific IE specialization that will make its graduates indispensable partners in this transformation. The specific recommendation (Section 6.2.1) is a dedicated Mining Systems Engineering track.

The second pathway is the expansion into digital and sustainability roles. The emergence of GMIT IE graduates in sustainability consulting, ESG advisory, and IT roles—documented in both the survey and the interview data—reflects a genuine diversification of career trajectories aligned with the WEF's identification of green economy transition and digital industrial transformation as the dominant drivers of engineering employment growth in 2025–2030 [8]. The ILO confirms these trends from a labor economics perspective [20]. GMIT has an opportunity to deliberately position its IE program as a feeder for these emerging high-value roles by incorporating sustainability engineering methods and digital transformation frameworks into the curriculum.

The third pathway is international labor market integration. The five graduates currently employed abroad—including Orgilsaikhan's international EPCM appointment in Oman—demonstrate that GMIT IE graduates can compete successfully in international engineering labor markets. International EPCM companies such as Worley and Lycopodium operate across dozens of countries and consistently recruit engineers with strong project coordination, process analysis, and technical communication competencies—precisely the GMIT IE profile. Formalizing this international pathway through IISE recognition or ABET accreditation [18] would provide the credential signal needed to accelerate international placement.

The fourth pathway is employer awareness building and institutional recognition. This study has established that functional demand for IE competencies already exists—graduates are employed at above-average rates and salaries, are creating measurable organizational value, and are advancing in their careers. The strategic gap is not in the supply of competent graduates but in the institutional infrastructure that would give their

contributions a recognized professional name. Building this infrastructure—through professional networking, employer engagement, and occupational classification advocacy—is the highest-leverage institutional investment GMIT can make.

5.8 Comparison with International GTS Benchmarks

Compared with international GTS benchmarks, GMIT's IE program performs strongly on the most direct employability indicators. The 85.7% employment rate exceeds the 75–80% typical for engineering graduates in comparable developing economy contexts [19]. The 64.7% employment within three months substantially exceeds Schomburg's six-month benchmark [4,11]. The salary premium of approximately 2.4 times the national average confirms that the labor market assigns significant value to GMIT IE competencies. On these dimensions, GMIT's IE program compares favorably with established engineering programs in the region.

On curriculum-industry alignment indicators, however, GMIT's performance presents more mixed findings. The data analytics skill gap (+0.94), the industry-specific knowledge gap (identified by 59.4% of graduates), and the moderate preparedness mean (3.59/5) indicate curriculum-industry misalignment in specific, addressable areas. These gaps are not unusual for relatively young programs in developing economy contexts; Teichler's analysis of engineering programs in comparable situations found that curriculum-industry gaps of this magnitude are typical and resolvable through structured industry engagement and curriculum revision [17].

The most significant area where GMIT's metrics fall below international best practice is employer awareness (2.79/5). UNESCO identifies employer awareness as one of the three primary quality indicators for program effectiveness [3], and a below-midpoint score indicates that the program's institutional ecosystem—employer relationships, professional recognition, disciplinary branding—requires development. This is not a reflection of educational quality per se; rather, it reflects the structural reality that developing the institutional recognition of a new discipline takes time and deliberate institutional effort that extends beyond the educational mission of the program itself.

6 Conclusion and Recommendations

6.1 Conclusion

This study set out to investigate the employment outcomes, skill utilization, employer awareness, and organizational value creation of Industrial Engineering graduates from the German-Mongolian Institute for Resources and Technology (GMIT), guided by three core research questions addressing career paths, disciplinary awareness, and future opportunities. The evidence base—comprising a quantitative survey of 35 graduates across cohorts 2020–2025 and in-depth interviews with three graduates working in mining EPCM, telecommunications, and heavy machinery—yields findings that are both analytically robust and strategically consequential.

The central finding of this study can be stated precisely: GMIT Industrial Engineering graduates are not an emerging workforce waiting to be integrated into Mongolia's industrial economy—they are already functionally embedded within it, demonstrably creating organizational value in roles ranging from international EPCM project engineering in Oman to KPI system development at Huawei Mongolia to root cause failure analysis for Caterpillar mining machinery. The 85.7% employment rate, the 64.7% employment-within-three-months rate, the above-average salary distribution, and the documented impact cases collectively confirm that GMIT IE graduates are high-value contributors to the organizations that employ them.

However, this functional embeddedness is systematically uncoupled from institutional recognition. The employer awareness mean of 2.79 out of 5—with more than 45% of graduates rating their employer's understanding of Industrial Engineering as 'poor' or 'very poor'—confirms that the professional discipline enabling these contributions is not yet recognized by the organizational environments in which those contributions occur. This decoupling between functional value and institutional recognition is the defining structural paradox of Industrial Engineering's current position in Mongolia, and it represents both the study's most important finding and its most urgent call to action.

Three structural constraints perpetuate this paradox. First, a critical curriculum gap in applied data analytics—documented by a skill gap of +0.94 on a five-point scale and independently confirmed by 43.8% of graduates identifying data analysis skills as insufficient academic preparation—limits the full realization of graduate potential in an increasingly data-driven industrial environment. Second, a gap in industry-specific knowledge, cited by 59.4% of graduates, reflects the limited depth of industry integration in the current curriculum. Third, the absence of formal institutional recognition for Industrial Engineering in Mongolia's occupational classification system and professional

landscape prevents the accumulation of a recognized disciplinary brand that could drive employer awareness.

The qualitative evidence from three in-depth interviews adds the explanatory layer that transforms these quantitative findings from a description of current outcomes into an understanding of the mechanisms that produce them. The cross-case theme of systems thinking—identified independently by all three interview participants as the most valuable and distinctive outcome of GMIT's IE education—confirms that the program is developing a genuinely transferable cognitive competency that creates professional value across entirely different sectors and organizational contexts. Orgilsaikhan Munkhbaatar applies it to navigate a multi-sector career in international mining EPCM. Oyungerel Ganbaatar uses it to transition from operational execution to analytical leadership in telecommunications. Zanabazar Altangerel deploys it to analyze machinery failures simultaneously from three organizational perspectives in a technically demanding specialization role.

The study also acknowledges its limitations honestly. The reduction of the interview sample from six to three—and the absence of employer interviews—reduces the evidential depth for the employer awareness dimension of the analysis. Future research building on this study should prioritize employer-side data collection to complete the picture of awareness-side dynamics.

In its totality, this study constitutes the first systematic empirical evidence base for GMIT Industrial Engineering graduate outcomes. Its findings provide the foundation for the specific, actionable recommendations that follow, and contribute to the broader agenda of building Industrial Engineering's institutional recognition in Mongolia to a level commensurate with its already-demonstrated functional value.

6.2 Recommendations

Recommendations are organized by stakeholder and directly referenced to specific GMIT modules where applicable.

6.2.1 For GMIT: Curriculum Development and Institutional Strategy

Recommendation 1 – Strengthen INDE307 to include applied data analytics. The data analytics skill gap (+0.94, Figure 2, Table 4.6) directly contradicts the program’s stated learning outcome: ‘apply information science and analyze big data for solving industrial engineering problems’ [21]. INDE307 Business Information Systems (4CP, Semester 6) should be expanded—or a companion module introduced—to include: (a) Python for operational data analysis (pandas, NumPy, matplotlib) with mandatory industry dataset project; (b) Power BI dashboard design aligned with IE performance indicators; and (c)

integration of Business Information Systems content with Operations Research methods from INDE402 [21]. The PROG101 (Algorithms and Programming, 4CP, Semester 1) foundation already gives students programming exposure; INDE307 should build directly on this to develop IE-specific analytics competency.

Recommendation 2 – Add MECH403 Production and Process Simulation as a recommended engineering elective. MECH403 (Production and Process Simulation, 4CP, Semester 7) is currently available as an engineering elective but receives insufficient systematic attention as a curriculum pathway [21]. Given that 56.2% of graduates engage in data analysis and reporting daily (Table 4.8), and that simulation-based decision-making is a core competency in mine planning and manufacturing optimization, MECH403 should be actively recommended to all Mining and Manufacturing track students.

Recommendation 3 – Develop a Mining Systems Engineering track using existing elective infrastructure. The Module Handbook already includes engineering electives directly relevant to mining: RMPE302 (Mineral Process Engineering I), INDE407 (Social Performance in Mining Operations), and INDE408 (Mine Water Management) [21]. GMIT should formalize these into a coherent Mining Systems Engineering track, adding one new elective in mine production scheduling and asset maintenance management developed in collaboration with Rio Tinto Oyu Tolgoi, Erdenet Mining Corporation, or Barloworld Mongolia—employers of the majority of graduates (Table 4.2).

Recommendation 4 – Restructure INTR301 Industrial Internship to close the industry knowledge gap. INTR301 (Industrial Internship + Reflection, 10CP, 14 weeks) is the primary mechanism for industry-specific knowledge development [21]; yet 55.9% of graduates cite this as insufficient (Table 4.7). The module should require: (a) structured competency assessment by industry supervisor, aligned with IISE graduate outcomes; (b) student deliverable mapping internship tasks to specific IE module competencies (INDE301–INDE405); and (c) reflective report addressing all three IE program pillars: engineering science, business sciences, and integrative skills [21]. GMIT should also expand the partner register by targeting a minimum of 15 active industry partners.

Recommendation 5 – Pursue IISE recognition or ABET accreditation. International accreditation would provide a verifiable quality signal to both domestic and international employers [18], directly addressing the awareness gap. The accreditation process itself—requiring documented curriculum alignment with international engineering standards—would also drive beneficial curriculum review against the Module Handbook commitments [21]. This is particularly strategic given that five graduates are already internationally employed.

Recommendation 6 – Establish an Industry Advisory Board. A formal advisory board of 6–8 industry representatives (mining, construction, IT, manufacturing) meeting twice annually should be established to: review curriculum annually against current skill requirements; identify emerging competency needs; and champion IE graduate employment within member organizations. The Module Handbook's emphasis on 'life-long learning' and adaptability [21] is best sustained through ongoing industry partnership.

6.2.2 For Students

Recommendation 7 – Develop applied data analytics competency before graduation. Given the +0.94 analytics gap (Figure 2, Table 4.6), students should supplement PROG101 and INDE307 by independently developing working proficiency in Python data analysis (pandas, NumPy, matplotlib), Power BI, and advanced Excel before graduation. Free resources including Kaggle Learn, DataCamp, and Microsoft's official Power BI training are sufficient. This is achievable within 3–4 months of focused study and directly targets the largest curriculum-industry mismatch identified.

Recommendation 8 – Maximize industry exposure from Semester 3, building on INTR201. The 6-week Basic Internship (INTR201, 2CP, Semester 4) should be treated as a minimum, not a target [21]. Students should proactively seek site visits, part-time roles, and project work at mining and engineering companies from Semester 3 onward. All three interview participants demonstrate that early, deep industry exposure—rather than academic performance alone—was the primary driver of rapid career advancement.

Recommendation 9 – Build and maintain a professional IE portfolio. Given the employer awareness deficit (2.79/5, Table 4.5, Figure 4), students cannot rely on disciplinary brand recognition. Each student should maintain a LinkedIn or professional portfolio documenting two to three specific IE contributions—framed in terms of organizational problem, IE method applied (referencing relevant GMIT modules), and measurable or qualitative outcome—to communicate competency value directly to employers who may not yet recognize the IE label.

6.2.3 For Industry and Policy

Recommendation 10 – Develop formal IE role categories in organizational structures. Companies employing GMIT graduates in planning, optimization, data analysis, and coordination functions should work with GMIT to develop formal IE job descriptions. Formal categorization enables more precise recruitment, accurate performance evaluation, and effective utilization of IE capabilities, creating value for organization and graduate alike.

Recommendation 11 – Establish IE as a recognized occupational category in Mongolia. The Engineers Association of Mongolia should collaborate with GMIT, the Ministry of Education, and the Ministry of Labor and Social Protection to add Industrial Engineering as a formal category within Mongolia's National Classification of Occupations. This is the foundational institutional infrastructure for IE market data, professional certification, and salary benchmarking.

Recommendation 12 – Establish a GMIT IE Alumni Professional Network. GMIT alumni should establish a formal professional network within or affiliated with the Engineers Association of Mongolia, with the mandate to: produce biannual industry-facing case study publications documenting IE graduate contributions; organize annual employer outreach events; and facilitate peer mentorship. The career case of Orgilsaikhan Munkhbaatar—whose international appointment came through professional referral from a former colleague—demonstrates that alumni networks multiply individual career capital into collective professional advancement.

The implementation timeline for these recommendations should be sequenced strategically. Curriculum changes (Recommendations 1–4) require 12–24 months of development, approval, and implementation. Accreditation pursuit (Recommendation 5) is a 3–5 year process. The Industry Advisory Board (Recommendation 6) can be established within 6–12 months. Student-facing recommendations (Recommendations 7–9) can be communicated immediately through existing orientation and advising channels. The employer and policy recommendations (Recommendations 10–12) require multi-stakeholder coordination and should be initiated through the Advisory Board once established.

The resourcing requirements for these recommendations are largely within GMIT's existing institutional capacity. Curriculum enhancements (Recommendations 1–2) require faculty development time and industry dataset procurement, both achievable without substantial external funding. Internship restructuring (Recommendation 4) requires administrative coordination and partner outreach, supported by the Advisory Board proposed in Recommendation 6. The professional network (Recommendation 12) is primarily alumni-driven and can be initiated with minimal institutional resources. Only accreditation pursuit (Recommendation 5) requires a significant multi-year commitment of faculty and administrative resources, and this should be sequenced after the other recommendations have created the curriculum quality improvements needed to support an accreditation application.

Taken together, these twelve recommendations constitute a comprehensive institutional development program for GMIT's IE discipline—one that addresses curriculum quality,

graduate preparedness, employer engagement, and professional recognition simultaneously. If implemented systematically, they would close the gap between IE's current functional embeddedness and the institutional recognition commensurate with its demonstrated value, positioning GMIT's IE program as the recognized home of one of Mongolia's most economically important engineering disciplines.

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