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Identifying essential competencies needed for success in industrial engineering fields of work

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***Abstract*—This study investigates the essential competencies including: 1) soft skills, 2) tools and techniques, and 3) software which are required for success in various industrial engineering fields of work. Several interviews and surveys have been conducted to identify these competencies as key determinants of professional success. The research highlights the importance of effective communication, problem-solving, and teamwork as the main soft skills. Moreover, tools and techniques and also software required in five popular fields of work have been extracted, i.e., quality control, marketing, human resource management, production planning and control, and project management. This study affords a roadmap and valuable insights for students, graduates, and practitioners to best be ready for these industrial engineering fields.**

Keywords—industrial engineering, working fields, soft skills, tools and techniques, software, interview, survey

I. INTRODUCTION

In the complex and dynamic world of industrial engineering, success in various working fields requires a combination of soft skills, tools and techniques, and also related software [1]-[3]. Soft skills encompass individual abilities in interactions and teamwork alongside [4].

A review of previously published research indicates that numerous studies have been conducted on the skills required in industrial engineering. However, many of these studies have focused on theoretical aspects and did not addressed the real needs and expectations of organizations. In this paper, through interviews with professionals and specialists working in different fields, efforts have been made to collect information directly from the workplace and to be closer to the actual needs of the industry.

Our research involved interviews with industrial engineers from various specializations, allowing us to identify and analyze the most frequently cited skills. This study's practicality lies in its ability to provide a comprehensive and operational perspective on the skills and tools needed in industrial engineering working fields. This practical and real-world approach is the key advantage of our research.

As shown in figure 1, in the initial phase of this study, several famous recruitment webpages such as e-estekhdam.com, daneshkar.net, and jobvision.ir were investigated [5]-[8]. This investigation revealed current most in-demand or popular fields within the industry including: 1) quality control, 2) marketing and sales, 3) human resource management, 4) production planning and control, and 5) project management. Subsequently, a questionnaire was designed to gather general information and specific requirements for these roles. This questionnaire was then distributed at 2024 Iranian International Industrial Engineering Conference (IIIEC 2024) [9]. The data collected from the questionnaire provided valuable insights for next steps of this research. Subsequently, in-depth interviews were conducted with experts in the most popular fields to achieve additional qualitative data. Finally, the integrated findings from both survey and interview data were utilized for developing a success roadmap in the five considered working fields, described in the next sections of the paper.

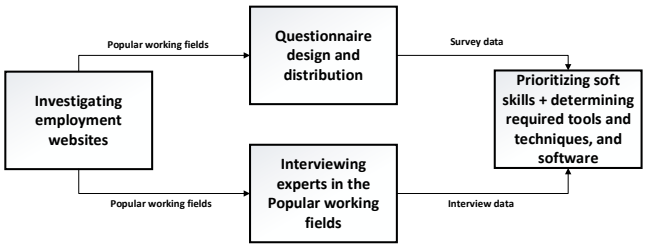

Fig. 1. Research method

II. QUALITY CONTROL FIELD

A. Soft Skills

Soft skills play a crucial role in quality control, and their type and level significantly depend on the nature and location of the work. Continuous study and training through various resources, including books and online education platforms like YouTube, are vital for staying updated and enhancing existent skills.

- Communication and negotiation: The ability to effectively communicate with colleagues, managers, and other organizational departments.

- Management and organization: Efficiently planning, prioritizing, and managing tasks and also projects.
- Analytical thinking: The ability to collect, analyze, and interpret data to identify problems and propose solutions.
- Continuous learning: A keen interest in learning new tools and techniques in quality control.
- Team work ability: Effective collaboration with other team members to achieve common goals.

B. Tools and Techniques

Knowledge of statistics and statistical analysis is a fundamental requirement in quality control. Other essential tools and techniques include:

- Descriptive and inferential statistics: Analyzing data to identify patterns and trends.
- Hypothesis testing: Evaluating statistical hypotheses for data-driven decision making.
- R and S charts: Using charts to analyze process variability and deviations.
- Correlation and dispersion coefficients: Examining and analyzing relationships between variables.
- Sampling methods and techniques: Selecting appropriate samples for testing and analysis.
- CP and CPK calculation: Evaluating process capability and identifying strengths and weaknesses.
- Document writing: Accurately writing reports and documentation.
- Sampling: Selecting suitable samples for analysis and drawing conclusions about whole population.
- Quality management systems: Implementing and maintaining quality management systems, e.g., ISO 9001.
- Quality improvement methods: Using methods like Six Sigma for continuously process improvement and defect reduction.

C. Software

The use of various software for data analysis and quality control is prevalent. Key software includes:

- Minitab: Specialized software for statistical analysis and quality control.
- Camunda: Management software tailored to the needs and preferences of organizations.
- Microsoft Visio: Software for designing process diagrams and documentation.
- Microsoft Excel: A primary tool for data analysis, chart drawing, and statistical calculations.

III. MARKETING/SALES FIELD

A. Soft Skills

In the sales and marketing field, soft skills are paramount and encompass many abilities essential for success. Key skills include:

- High follow-through and organization: The ability to diligently follow up on tasks and projects accurately and persistently.
- Management and organization: Planning and organizing activities to optimize sales and marketing processes.
- Communication and negotiation: Effectively communicating with customers and colleagues and negotiating in order to achieve agreements.
- Flexibility and adaptability: The ability to adjust to the changing market conditions and customer needs.
- Decision making and high inference: The ability to make sound and effective decisions based on emerging conditions and needs.
- Emotional intelligence (EQ): The ability to understand and manage one's and others' emotions to build effective relationships.
- Creativity: The ability to generate innovative ideas and solutions to improve sales.
- Time management: The ability to plan and manage time to handle multiple tasks.
- Networking: Building and maintaining relationships with key industry individuals.

B. Tools and Techniques

In sales and marketing, familiarity with various tools and techniques is essential. Some critical tools and techniques include:

- CRM (Customer Relationship Management): Managing customer relationships to enhance customer experience and increase sales.
- ERP (Enterprise Resource Planning): Managing organizational resources to integrate various business processes.
- Data analysis: Using data to identify sales opportunities and threats.
- Content marketing: Creating and distributing content to attract potential customers.
- Digital marketing: Using digital channels to promote products and services.
- Consultative selling: Providing advice to customers to help them choose the best products or services.
- Digital marketing tools: Google Analytics, Google Ads, and social media management tools.

C. Software

The use of various software for data analysis and process management in sales and marketing is highly prevalent. Key software include:

- Microsoft office: Core tools for conducting analyses, preparing reports, and managing data and more specific: Microsoft Excel for data management and performing statistical and financial analyses. Also

Microsoft Access for managing and maintaining large datasets.
- Accounting software: For financial and accounting management.
- CRM Software: CRM software for managing customer relationships, such as Salesforce and HubSpot.
- ERP Software: ERP manages organizational resources, e.g., SAP and Oracle.
- Data analysis software: Such as Power BI for sales data analysis.

IV. Human Resources Management

A. Soft Skills

In human resources, soft skills play a crucial role in individual and organizational success because this field includes much more individual interactions. Key skills include:

- Negotiation: The ability to negotiate and manage discussions to resolve conflicts and reach favorable agreements.
- Resilience: The capability to cope with workplace challenges and stress.
- Management and organization: The ability to efficiently manage activities and processes.
- Writing Skills: Proficiency in writing and drafting documents, policies, and guidelines.
- Willingness to learn: An ongoing interest in learning and updating knowledge.
- Creativity and vision: The ability to develop innovative solutions for organizational problems.
- Ability to seek advice: Recognizing the need for consultation and seeking guidance from others.
- Interpersonal skills: The ability to build strong relationships and collaborate with others.
- Emotional intelligence: Understanding one's and others' emotions and managing relationships effectively.
- Problem solving: Identifying and resolving HR-related challenges.
- Flexibility: The ability to adapt to changes in the work environment.

B. Tools and Techniques

In Human resources, utilizing various tools and techniques to improve and optimize processes is essential. Some critical tools and techniques include:

- Employee training and development: Identifying training needs, developing training programs, and educating employees.
- Documentation and record keeping: Recording and maintaining information in physical or electronic form.
- Interpreting human resources policies and laws: Familiarity with human resources-related laws and regulations.
- Administrative activities: Managing daily administrative tasks such as maintaining information files and processing documents.
- Data analysis and data Mining: Using data for decision making on human resources issues (e.g., salary analysis and KPIs).
- Performance evaluation: Assessing employee performance and giving feedback.
- Personal development: Planning and implementing personal development programs for employees.
- Change management: Managing organizational changes and helping employees to adapt with these changes.

C. Software

The use of various software tools is crucial for human resources management. Key software includes:

- Microsoft Excel: For data analysis and reporting.
- Power BI: For data analysis and creating management dashboards.
- ERP (Enterprise Resource Planning): For overall management of organizational resources.
- Microsoft Visio: For process mapping and design.

V. Production Planning and Control

A. Soft Skills

In production planning, soft skills play a critical role, encompassing a range of abilities and personal attributes essential for success. These critical soft skills include:

- Systematic thinking: Understanding the interconnections between various components of the production system and the impact of changes in one area on others.
- Flexibility and adaptability: Being prepared to handle changes and unforeseen issues in work environment.
- Decision making: The capability to make quick and accurate decisions in response to unexpected events, such as power outages.
- Communication and negotiation: Effectively communicating with other organizational units, e.g., sales and suppliers.
- Management and organization: The ability to efficiently manage and organize activities and schedules.
- Dynamic and active mindset: Having a proactive personality ready for continuous change and development.
- Time management: Prioritizing tasks and managing time for optimal task completion.

- Teamwork: Collaborating with team members to achieve shared and common goals.
- Problem solving: Identifying and resolving complex challenges in the production process.

B. Tools and Techniques

Production planning involves optimizing resource allocation and production schedules to meet customer demand efficiently. It encompasses a range of tools and techniques to streamline operations and minimize costs. Other required tools and techniques include:

- Product prioritization: Using Microsoft Excel or MCDM techniques to prioritize products based on the required raw materials or other criteria.
- Raw material management: Purchasing raw materials from suppliers and planning delivery dates.
- Production control: Controlling waste, reviewing times, and tracking order process.
- MRP systems (Material Requirements Planning): Implementing MRP systems to control inventory and plan material requirements for optimal production.
- Industrial automation: Utilizing automation software to control material flow between production units.
- Data analysis: Employing data analysis tools to optimize production processes.
- Simulation and mathematical modeling: Using mathematical models or simulation to improve or optimize production processes.

C. Software

Production planning software is a digital tool designed to optimize the manufacturing process by efficiently allocating resources and scheduling production activities. Some popular software include:

- Microsoft Excel: A primary tool for data analysis, production planning and report generation.
- Power BI: A powerful tool for data visualization and creating management dashboards.
- Microsoft Access: For database management and creating information systems.
- VBA and SQL: For programming in Excel and accessing production databases.
- GAMS: For modeling and optimizing complex production issues.
- Arena / Any logic: For simulating and decision making production and also delivery processes.

VI. Project Management Field

Even several standards like Individual Competence Baseline (ICB) [10] or Project Manager Competency Development Framework [11] have been considered project managers' competencies; in order to be aligned with other popular working fields and our research method, project management field has been considered too.

A. Soft Skills

In project control, soft skills are critical and encompass a set of abilities and personal characteristics essential for success. These critical soft skills include:

- Multitasking: Effectively managing multiple projects and tasks simultaneously.
- Networking with individuals: Establishing broad and beneficial connections with various individuals and teams.
- Active listening: Paying attention to the needs and concerns of stakeholders and colleagues.
- Follow-up and inquiry: A demanding and inquisitive personality for tracking project details.
- Communication and Negotiation: The ability to effectively communicate with team members, managers, contractors, and other project stakeholders.
- Problem solving: Identifying and addressing complex challenges during project execution.
- Time Management: Prioritizing tasks and managing time to complete the project within the stipulated timeframe.
- Analytical thinking: The ability to collect, analyze, and interpret data for decision making.
- Flexibility and adaptability: The ability to adapt to changes during project execution.
- Team work: Effective collaboration with other project team members.

B. Tools and Techniques

In project control, various tools and techniques are essential for managing and executing projects. Some critical tools and techniques include:

- Blueprint reading: The ability to read and understand project plans and designs.
- Reporting: Preparing weekly and monthly reports containing specific data to inform about the project status and progress.
- WBS (Work Breakdown Structure): Break down the project into smaller sections to manage them.
- PMIS (Project Management Information Systems): Using project management information systems to monitor and control projects.
- CBS (Cost Breakdown Structure): Break down the project costs for managing and controlling them.
- Monetary and physical weighting: Assigning weight to activities based on importance and/or costs.
- Familiarity with legal matters and regulations
- Budget planning: Preparing budgets and documenting processes and activities.
- Scheduling: Creating a detailed schedule for project activities.
- Risk analysis: Identifying and assessing project risks and developing a risk management plan.

C. Software

The use of various software for project management and control is highly prevalent. Some popular software includes:

- Microsoft Project (MSP): Software for planning, scheduling, and managing projects.
- Primavera P6: Specialized software for managing large and complex projects.
- Microsoft Office (Excel, Word): Essential tools for creating reports, tables, and documentation.
- Power BI: For data analysis and creating management dashboards
- AutoCAD: For project drafting and design or generating WBS based on the designs.

VII. Conclusion

This paper considered requirements needed in the five IE working fields and aims to help students and graduates to identify their competencies gap and consider ways to improve and bridge it for their future employment. By understanding the critical aspects of each working field. Moreover, students can choose their future career paths and academic specializations based on their interests and talents.

Figure 2 compares the frequency of all extracted soft skills in different fields.

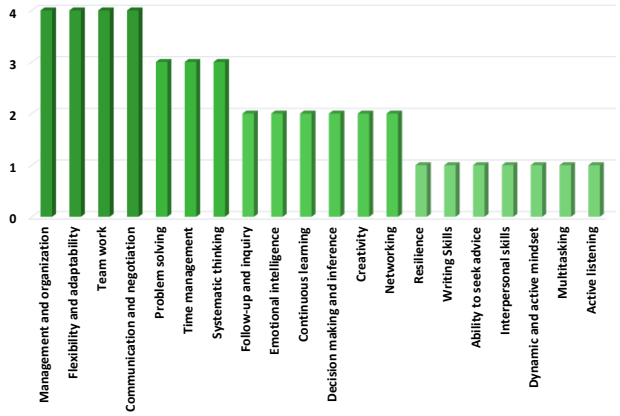

Fig. 2. The frequency of all extracted soft skills

As shown in figure 2, management and organization, flexibility and adaptability, team work, and communication and negotiation are generally required while resilience, writing skills, ability to seek advice, interpersonal skills, dynamic-and-active mindset, multitasking, and active listening are needed in specific working fields.

University professors can also use the findings of this research to align their teaching environments and educational content with the needs of the job market and the demands of organizations. The results of this study demonstrate the soft skills, tools and software that can enhance the performance and efficiency of industrial engineers in the workplace. By identifying and analyzing the key skills and necessary tools, this article plays a crucial role in bridging the gap between academic education and the actual needs of the industry, providing reassurance and confidence in career choices.

The scientific contribution of this article lies in identifying and emphasizing the importance of both soft and technical skills in the workplace. This research can serve as a reference for students, graduates, and even professionals active in the field of industrial engineering.

Future research can focus on other industrial engineering disciplines and delve deeper into the specific tools and software of each discipline. Moreover, the results can be compared with other published researches.

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