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Alignment of vocational education curricula with job requirements in industrial sector: Analysis study

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Abstract

Many technical and vocational education institutions suffer from weak outcomes represented in qualifying their graduates to keep pace with the requirements of the industrial sector, and the negative impact on employment rates. This research has presented a way to link the training programs and curricula with the requirements of the industrial sector for the category of technicians and plant operators. By verifying the announced technical requirements for the jobs of technicians and plant operators in industrial companies with the outputs of courses and training programs in technical and vocational education institutions, as an example of this in the Jubail Technical Institute. In this article, a sample of (50) job advertisements for jobs of technicians and plant operators were used in order to extract the most required important technical skills. For this purpose, several tools and methods were used, such as text mining using the program in https://voyant-tools.org, in addition to Excel. Critical to Quality Tree was also used to clarify the importance of the technical skills required by the industrial sector. In addition, the cause and effect matrix which was used to link and evaluate the impact of training courses on the required technical skills. The article reached specific results, including extracting three of the most important skills required and declared for jobs in the technicians and plant operators and linking them with the training courses in the training program for plant operators. The impact of each training course on the required skills in the labor market, which facilitates the work of developing training courses to keep pace with the continuous improvement in the requirements of the labor markets for skills of the announced jobs.

Keywords: Vocational Education; Plant Operator; Job Skills; Training Courses; Industrial Sector

1. Introduction

1.1. Industrial sector

An industrial sector encompasses a grouping of businesses or organizations involved in similar economic activities or the production of comparable goods or services. Such sectors are typically delineated based on the nature of their offerings and the similarities in their production processes. Playing a pivotal role in the broader economy, industrial sectors contribute significantly to economic growth, employment, and technological progress. Development experiences worldwide include many indications of the role of the industrial sector in formulating and achieving the objectives of development plans. This situation called for the majority of countries to develop and diversify their production base to contribute to increasing economic growth rates, thereby improving societal and economic welfare [1]. The industrial sector is integral to the overall economic development of a nation, exerting influence through economic growth, job creation, technological innovation, and global competitiveness. Within the different economic systems, there is a dominant belief about the importance of the manufacturing sector, and its forward and backward linkages. It is assumed that continuous growth and development in manufacturing will lead to an increase in

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technological intensity and also drive other sectors to continuous development [2]. Noteworthy factors underlining its significance to encompass economic growth, job creation, technological advancement, and income generation. Serving as a cornerstone for economic development, the industrial sector, lays the groundwork for growth, employment, innovation, and global competitiveness. For many countries, growth and development is synonymous with industrialization, and that is primarily because once the industry of a country starts to grow, economic ease and urbanization is inevitable [3]. Nations strategically investing in and nurturing their industrial sectors are better positioned to attain enduring economic prosperity. In the economic landscape of Saudi Arabia, industries play a critical role in development. The Kingdom has made substantial advancements in industrialization as part of its economic diversification endeavors, driven by economic diversification, increased Gross Domestic Product (GDP) contribution, technological advancement, and skill development. The Saudi government is committed to overall growth and development of the economy and develops various industrial sectors for balanced contribution to GDP. [4]. The efforts exerted by the government for the support of industrial development covered several basic spheres including implementation of required infrastructure, construction of Jubail and Yanbu industrial cities, construction of industrial cities in various regions of the Kingdom [5]. Consequently, the industrial sector in Saudi Arabia emerges as a key driver for economic diversification, job creation, technological progress, and overall economic development. As the country pursues the realization of its Vision 2030 goals, which considers the most important entrance comprehensive development. [6] Industries are poised to centralize efforts in transforming and modernizing the Saudi economy. The objectives of the industrial sector, both globally and in specific countries like Saudi Arabia, typically align with economic development, job creation, technological advancement, and global competitiveness. These goals mirror the broader economic and developmental aspirations of the industrial sector, with a specific emphasis on the distinctive context and priorities of Saudi Arabia. The successful attainment of these objectives contributes significantly to the overall prosperity and sustainability of the country's economy.

1.2. Vocational Training Education

Vocational Education and Training (VET), also known as technical education, encompasses educational programs and courses tailored to prepare individuals for specific careers or professions. In this type of education, students are expected to acquire their professional skills through on-the-job training and demonstrate their acquired skills in the labor market after graduation. VET has a strong decisive role in terms of the competitiveness of countries in production and markets [7]. In contrast to traditional academic education, which often covers a broad spectrum of subjects, vocational education prioritizes practical, hands-on learning experiences, aiming to equip students with the skills and knowledge essential for particular trades or occupations. A clear and logical progression of the required skills are essential to the development of responsible and safe process operations personnel. The trainees should be challenged on a daily basis and a dynamic approach to learning should be exercised by the instructor [8]. The National Association of State Directors of Career Technical Education Consortium acknowledged that: “VET provides students and adults with the technical skills, knowledge and training necessary to succeed in specific occupations and careers. It also prepares students for the world of work by introducing them to workplace competencies that are essentially no matter what career they choose. And, VET takes academic content and makes it accessible to students by providing it in a hands-on context.” [9]. The key characteristics of VET include skill development, industry-relevant training, hands-on learning, a specific career focus, and responsiveness to labor market needs. The likely advantage of VET, is that its graduates enter the labour market with work experience and have the option of continuing to higher education [10]. VET holds significance for various reasons, making substantial contributions to individual career development, economic growth, and societal well-being. Also for preparing individuals for the workforce, because trained and skilled workforce has significant role in Economic development, Industrialization, Individual development and to attract foreign direct investment [11]. Common sources for vocational training include vocational schools, community colleges, apprenticeship programs, government-sponsored training initiatives, employer-based training, local workforce development centers, and private training institutes. Various institutions and organizations offer vocational training to provide individuals with practical skills and knowledge in specific trades or occupations. So when exploring vocational training options, considerations such as program duration, curriculum relevance, hands-on experience, accreditation, job placement assistance, and potential financial aid should be taken into account because VET qualifications should not only equip students with the knowledge and skills they need for work, but also ensure that they have adequate language, and skills they need for further learning as the basis for changes to their existing work and for occupational progression [12].

1.3. Curriculum

A curriculum is a systematically organized plan or course of study that delineates the content, learning objectives, instructional methods, assessments, and resources employed to guide the teaching and learning process within an educational program. Curriculum is the passageway to the growth of professional knowledge and skills which facilitate the flow from theory to practice [13]. Serving as a guiding framework for educators, the curriculum functions as a

roadmap, facilitating the organization and delivery of content to learners. Its applicability spans various educational levels, ranging from preschool to higher education, and may encompass an array of subjects and disciplines. Well-defined objectives simplify the selection and design of methods for measuring learning outcomes, throughout answering the following questions: Content: what do students need to know about the subject? Action: how do we want students to use the knowledge? Context: under what circumstances will students be expected to demonstrate their knowledge? Performance: by what standards will students' performance be judged? [14]. The design and implementation of a curriculum are pivotal factors influencing the effectiveness of an educational program. A well-structured curriculum enhances the teaching and learning experience, supports student achievement, and contributes to the overarching goals of education. It spells out what to teach, how to teach and what students are expected to do at the end of the teaching [15]. It defines learning goals, shapes content, provides structure, promotes active learning, fosters critical thinking, and prepares students for real-world applications. The curriculum holds a profound impact on the learning experiences and outcomes of students, influencing their educational journey in multiple ways. A thoughtful and well-designed curriculum plays a significant role in fostering the development of knowledge, skills, and attitudes, ultimately preparing students for success in their academic pursuits and beyond.

1.4. Process Technician/ Operator

A process technician or process operator is a professional responsible for supervising and controlling the equipment and machinery utilized in industrial processes. In process industry, the human operator often has a key role in ensuring good overall performance of the plant, despite the increased level of automation and advanced control systems [16]. These processes are integral to diverse industries, including manufacturing, chemical processing, oil and gas, pharmaceuticals, and food production, among others and the key responsibilities of a process technician or process operator to work in these industries encompass operating machinery, ensuring quality control, compliance with safety regulations, troubleshooting, monitoring and recording data, optimizing processes, and responding to emergencies. In general, they are supposed to make scientific equipment function seamlessly—they are responsible for making the machines 'work'—and they manage the ordering and integrity of information and other materials in the laboratory. A vast portion of their work is 'troubleshooting'—anticipating, diagnosing, solving and documenting difficulties that arise, particularly with machines and the smooth production of usable data [17]. The specific duties and responsibilities of a process technician may vary based on the industry and the characteristics of the manufacturing or production process. Educational prerequisites for process technicians can vary, but many individuals in this role possess a background in technical education, such as an associate degree or certification in a relevant field. On-the-job training is often provided to familiarize process technicians with specific equipment and processes within a particular industry. Process operator skills involve a variety of cognitive skills, many carried out at a control panel, and some manual work, such as setting up equipment. The particular mixture of these skills encountered depends on the particular plant, process and preference of management. [18]. The learning outcomes for a Process Technician diploma program may differ depending on the institution and industry focus (e.g., manufacturing, chemical processing, oil and gas). However, common learning outcomes associated with these programs include an understanding of industrial processes, equipment operation, safety procedures, troubleshooting skills, quality control, environmental awareness, equipment maintenance, and communication skills.

2. Background

2.1. Jubail technical institute

Jubail Technical Institute (JTI) stands as a prominent institution in the kingdom of Saudi Arabia, having been inaugurated by the Royal Commission for Jubail and Yanbu in 2004. The primary goal of the institute is to deliver high-quality education and training in the domains of process operation, chemical, electrical, mechanical, and information technology. JTI is dedicated to the training and preparation of scientifically and practically qualified national cadres, equipped with advanced vocational skills, enabling them to carry out operational and maintenance tasks in various companies and factories within the region. As part of its commitment to achieving international standards. The academic curriculum at JTI is precisely crafted to align with industrial requirements and national objectives, striking a balance between knowledge and skills. Accordingly, 80% of the curriculum is devoted to the practical dimension, emphasizing hands-on experience. The courses prioritize the acquisition of knowledge, the development of pertinent practical skills, and the ability to guide Saudi youth towards a culture of productivity, fostering self-reliance. JTI's commitment to excellence is evident in its holistic approach to education and its continuous efforts to meet both local and global standards.

2.2. Process Operation/ Operator Curriculum

The learning outcomes of Process Operation/ Operator Curriculum collectively equip graduates of Process Technician diploma programs with the skills and knowledge necessary to contribute to various industries, particularly in roles related to the operation and optimization of industrial processes. The specific curriculum requirements for a diploma can vary depending on factors such as the institution offering the program, the country or region, and the specific focus of the diploma. Despite potential variations, a typical curriculum for a diploma in chemical skills generally covers a range of foundational and specialized topics. For a more detailed understanding of the program's content and focus, it is essential to review the specific curriculum and learning objectives outlined by the institution offering the program. As the implementation of production-based learning assists the students to prepare before joining the occupational world, to develop critical thinking, to have good moral attitudes and to motivate students to be active in learning. The content of vocational education should focus on adjusting to the requirements of the labour market [19]. A comprehensive overview of potential curriculum requirements may include foundational courses in math, physics, and chemistry fundamentals, along with chemical technology courses that delve into chemical process technology, laboratory techniques, process control and instrumentation, quality control methods, safety in the chemical process industry, technical writing, professional communication, and practical training. As VET focus on skill oriented that is also known as skill based training. These courses are designed to meet the specific needs and requirements of industries in the region. This training to concentrate on developing and applying specific skills and behaviors. Learners must spend the majority of their training time engaged in learning, developing, and practicing skills in a variety of hands-on, real-life scenarios [20]. The Department of Chemical Skills at JTI is dedicated to producing proficient process operators and technicians for local process industries. The department offers trainees to the opportunity to undergo practical, in-depth training on the equipment commonly used in contemporary industrial manufacturing and production plants. This approach ensures that students are well-prepared for entry-level positions in diverse settings, including petroleum refineries, petrochemical plants, fertilizer plants, and chemical manufacturing plants. The department is well-equipped and features a range of laboratory facilities, including the Pilot Plant developed for the industrial environment in which trainees are developing the necessary skills to function within the process industry. [8] the Pilot Plant is used for the process troubleshooting course, which presents instructions in the different types of troubleshooting techniques, procedures, and methods used to solve process problems also case studies of troubleshooting on different systems and equipment such as distillation, pumps, compressors, and heat exchangers. There is also Process Equipment Lab is which courses about process equipment and systems & operations are being taught, these courses give an overview of important process equipment including Valves, Piping & Pipe Fittings, Pumps, Compressors, Heat Exchangers, Filters, Dryers, Tanks & Vessels, Columns & Cooling Towers, Turbines, Motors, Extruders, Furnaces, and Boilers. Also, the courses give an overview of important process systems including reactor systems, separation systems and utilities systems. The course also demonstrates process plant operational procedures including but not limited to start-up/shut down procedures, commissioning procedures, turnaround procedures etc. In addition, the Process Control Lab is used for the process control course, which provides the knowledge and hands-on experience of process control. It demonstrates how different process instruments are integrated to measure and control process variables. The study of ON-OFF and PID control are introduced in this course. The students will learn the necessary skills to monitor the operation of process control system. It comprises both theoretical and laboratory practical sessions. Besides that, in Piping & Instrumentation Lab, the process instrumentation course covers the fundamentals of process instrumentation used in industry. The course mainly focuses on the introduction of process instrumentation, basic principles of instrumentation and its evolution, instrumentation used for temperature, pressure, level and flow measurements, basic concepts of control, final control elements and process instrument symbols. In Simulation Lab, there is a course which gives the students an overview of the Operator Training Simulator (OTS) system. It helps them to understand how an OTS would be useful in operating and familiarizing themselves with a Distributed Control System as well as getting exposure on various scenarios like Normal Operations, Malfunctions and Disturbances. The students will also learn how to develop the skills and understanding required for creating and running dynamic simulations. To cover the safety and quality control in the industries, there is an industrial safety and process quality control lab, which is used to introduce the concepts of health and safety both for students who will receive off-the job training and for those who are involved with the industrial processes. Also, it aims to form within the students' sound attitudes and to make them safety conscious while making quality products by understanding the concepts of maintaining the quality of environment within which a product is being made. Topics included cover the following areas: general safety, physical hazards, chemical hazards, fire safety, safety signs, and environmental pollution and regulations. To understand the processes there is an industrial process lab, and the aim is to develop a course to understand the industrial process in which an overview of design and operation of petroleum and gas processing facilities is given including hydrate suppression, dehydration, sweetening, sulfur recovery, refining operations are involved at a large degree of processes. In addition, there is a course which teach the students the basics of process diagrams by introducing different symbols involve in different types of diagram to understand different kind of the industrial processes. Last but not the least, a chemistry Lab and Applied Physics Lab is also established to develop the fundamental concepts of chemistry involve in all the chemical process which help to understand the manufacturing of various products and also the course covers utilizing

different laboratory techniques for testing and analyzing the product. Crucially, a curriculum that fulfills industry requirements is instrumental in creating a well-prepared and job-ready workforce. Its benefits extend beyond individual graduates, positively impacting the growth and competitiveness of industries, the overall economy, and the success of the country in the global market.

2.3. Industrial job requirements

A holder of a diploma in process operation is typically well-prepared for various entry-level positions within industries involving chemical processes, manufacturing, and laboratory work. The specific job requirements can vary based on factors such as the industry, the company, and the nature of the role which is published in job description of a particular job advertisement. A job description is a written document that outlines the duties, responsibilities, contributions, behaviors, outcomes and required qualifications for a specific job in an organization [21]. Common industrial job requirements for a process operation diploma holder include, but are not limited to, the operation and monitoring of chemical processing equipment, adherence to standard operating procedures, conducting routine checks, and ensuring compliance with quality control standards. Indeed, the role of operators has undergone a continuous transformation over the years, influenced by the main production paradigms that have affected how companies approach their manufacturing and logistics operation [22]. Additionally, for roles related to laboratory work and quality control, requirements may involve performing chemical analysis and testing using laboratory equipment, preparing and analyzing samples, recording data, adhering to safety protocols, conducting inspections and tests to ensure product quality, monitoring and analyzing production processes, addressing quality issues, and maintaining laboratory cleanliness. Furthermore, Operators in the process industry are required to perform complex and safety-critical tasks with optimum efficiency. The complex nature of these tasks necessitates that operators manage adaptive automation, multilevel communication, and decision-making in dynamic work contexts [23]. In addition to this, for positions such as production assistants and process control technicians, interesting requirements may encompass assisting in the preparation of raw materials and production setups, maintaining process equipment, monitoring and controlling industrial processes using control systems, troubleshooting and addressing issues related to process control, implementing and enforcing safety protocols, conducting safety inspections, and investigating and reporting incidents or accidents. In addition to the technical skills acquired during the diploma program, employers often value qualities such as attention to detail, teamwork, communication skills, and a strong commitment to safety and quality standards. Entry-level positions provide opportunities for further on-the-job training and professional development in the chosen industry. Individuals seeking industrial jobs as operators or technicians typically benefit from a combination of technical, interpersonal, and problem-solving skills. Key skills often sought after in the industrial sector include technical competence (covering equipment operation, troubleshooting, process understanding, and quality control), safety awareness (including knowledge of safety protocols and emergency response), and general skills such as communication ability, problem-solving behavior, adaptability to changing conditions, mechanical aptitude, documentation skills, computer literacy, physical endurance, and ethical conduct. When combined with relevant education and experience, these skills can enhance an individual's competitiveness in securing and succeeding in industrial roles as operators or technicians. Employers often seek candidates who can demonstrate a strong combination of technical expertise, safety awareness, and effective communication and teamwork skills. Moreover, having a curriculum that fulfills industry requirements contribute to employability, reduces skills gaps, increases job placement, enhances global competitiveness, fosters job satisfaction, and ensures adaptability to technological changes, reduces skills gaps, increases job placement, enhances global competitiveness, fosters job satisfaction, and ensures adaptability to technological changes.

Research Objective

This research aims to examine the extent to which process technician requirements are met by vocational and technical training institutions through the adoption of useful, industrial curricula that are closely related to the targeted industrial sectors. This is explained by measuring the correlation of the technical required skills by companies in the industrial sector through their job advertisements for the category of process operators and industrial operations technician. The research also shows the most important training courses which provided by vocational and technical training institutions related to the needed qualification of industrial operations technicians and operators to meet the requirements of the labor market and meet its needs.

3. Methodology

To reach the research objectives, a sample of job advertisements was collected that included all the requirements for the job applicant, mainly process operators and industrial operations' technician. This sample represents a basis for the industrial sector’s requirements for the most important jobs assigned to process operators and industrial operations' technician, with the aim of revealing the required skills to be developed in the vocational and technical training

institutions. The job advertisements included the job description, requirements for the job, and the qualifications and skills required for the job. The sample was shortened to (50) job advertisements that are closely related to the research objective, with (24) job titles announced by (40) companies in the recent period from January (2022) to November (2023). These jobs mainly required diploma qualifications. The most important job titles are summarized as follows: Plant Operators, Control Room Operators, Equipment Operators, Field DCS Operators, Field Operators, Finishing Operators, Laboratory Technicians, Machine Operators, Process Operators, Production Technicians, Production Operators, Senior Operators and Shift Foreman. The text mining method was used in the job description by using the website (https://voyant-tools.org) and the Excel program to calculate the frequency of the most important words and then the sentences behind them to reveal the most important skills required by advertisers in the industrial sector. Consequently, the required skills and competencies have been summarized into three main and basic required technical skills. The Critical to Quality Tree (CQT) tool was used to clarify the importance of the three main skills, their effects, and their connection to vocational and technical training. Finally, the cause and effect matrix tool was used to clarify the relationship with the training courses in the process operation skill department, to evaluate the extent of the relationship with these courses and to clarify the impact of the courses on mastering the most important required skills which needed by the industrial sector. All of this in the sake of measuring the quality of meeting process operators and industrial operations technician requirements by vocational and technical training institutions through adopting useful, industrial curricula that are closely related to the targeted industrial sectors to meet and exceed the expectations of the industrial sector.

4. Results

4.1. The keywords in the jobs' descriptions

After the sample of information was collected, the website (https://voyant-tools.org) was used to search for the most important words related to the plant operation specialty. This was also confirmed via the Excel program and the result was as shown in Table No. (1) below, where the word (Equipment) appears with a repetition of (79) in the job descriptions of the advertised jobs, while the repetition of the word (Safety) is (34) repetition.

Table 1 The most important related technical words in jobs' descriptions and their repetition

No.	Key Words	Repetition
1	Equipment	79
2	Plant Operation	59
3	Safety	34

4.2. The technical Sentences in the jobs' descriptions

An attempt was made to understand the context of the words which extracted above, also by referring to the job descriptions of the jobs advertised and through the same website. The context of the above keywords was extracted through several sentences and phrases. This was also confirmed via the Excel program, and the result was as in Table No. (2), where the word (Equipment) formed four sentences and phrases, while the words (Plant Operation) formed five sentences and phrases.

Table 2 The most important related technical Sentences in jobs' descriptions

No.	Key Sentences
1	Operates Equipment
2	Monitoring Equipment
3	Check Equipment
4	Record Data Equipment
5	Comply With Safety Rules And Regulations
6	Follow All Safety Procedures

No.	Key Sentences
7	Ensure The Safety Of Personnel
8	Operate The Plant
9	Monitor The Plant
10	Troubleshoot Plant Operation
11	Conduct Operation Activities
12	Check The Operational Parameters

4.3. The Major Needed Tasks

Based on the results in 5.1, the sentences and phrases in table (2) have been collected and summarized as they appear in Table (3) in three main technical skills. These required skills represent the most important skills that must be available for the process technician and operator qualification programs. All of this is done to test its availability and effects in training curricula and programs in vocational and technical training institutes.

Table 3 The major needed tasks that required by the industrial sector

No.	Major Needed Tasks
1	Operate, Monitor, Check and Record data of the equipment
2	Comply with safety rules and regulations, Follow safety procedures and Ensure the safety of personnel
3	Plant Operation, Conduct operation activities, Check the operational Parameters and Troubleshoot plant operation

4.4. The critical to quality tree for the three main skills

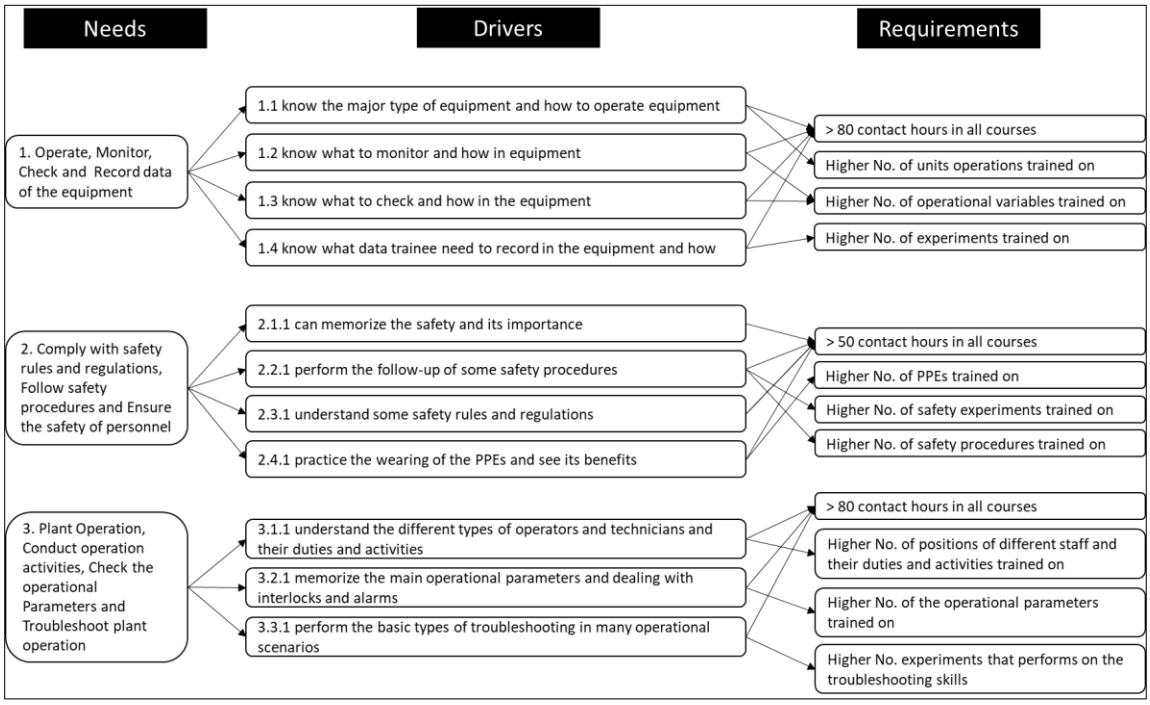

Figure 1 The critical to quality tree for the three main skills

In Figure No. (1), the tool of critical to quality tree appears, in order to consider the attempt to interpret and understand the requirements of the industrial sector. Specifically, regarding the three specific technical skills that were summarized from the job descriptions. In addition to the specific requirements that training institutes need to adopt in their courses

and training programs and to act accordingly. To achieve them and constantly improve their targets. The figure shows some requirements in the training courses that help achieve skills acquisition, such as the minimum training contact hours for each major skill required by the industrial sector. It also shows some of the sub-skills required, such as the minimum equipment or experiments required to be trained on. There are also some conditions that must be met, such as the use of personal protective equipment to enable the trainee to get used to using them when he joins the real work environment.

4.5. The cause and effect matrix of the training courses and the needed skills

To reveal the relationship and correlation between (input variables) the skills acquired from the training courses in the programs of process technicians and operators and (outputs) the technical skills required by the industrial sector, which were summarized above. The cause and effect matrix was used to analyze the root causes of the effects between the training courses, and the rating scales 1, 3 and 5 used, where a high value means great effect, as shown in Table No. (4). The table shows that there are two training courses that greatly affect the operation, monitoring, inspection and recording of equipment data, while plant operations, conducting operating activities, verifying operational parameters and troubleshooting plant operation errors are affected by six courses compared to the skills of adhering to safety rules and regulations. Following safety procedures and ensuring the safety of employees, which is mainly affected by two courses.

Table 4 The cause and effect matrix for the relationship of the training courses and the needed skills

Trained Skills (Inputs)	Major Needed skills (Outputs): Operate, Monitor, Check and Record data of the equipment		Comply with safety rules and regulations, Follow safety procedures and Ensure the safety of personnel		Plant Operation, Conduct operation activities, Check the operational Parameters and Troubleshoot plant operation		Total
Course	5		3		5		
Process Technology – I (Equipment)	5	25	3	9	1	5	39
Process Instrumentation	3	15	1	3	3	15	33
Industrial Safety	1	5	5	15	3	15	35
Industrial Processes	1	5	1	3	5	25	33
Process Technology – II (Systems & Operations)	5	25	3	9	5	25	59
Process Control	1	5	1	3	5	25	33
Process Simulation	3	15	1	3	5	25	43
Process Troubleshooting	3	15	3	9	5	25	49
Applied Physics	3	15	1	3	3	15	33
Chemistry for Process Operators	1	5	5	15	3	15	35
Process Diagrams	1	5	3	9	5	25	29
Process Quality Control	3	15	3	9	5	15	39
Total	150		90		230		

5. Discussion

The results drawn from this research provide the possibility of using the method to obtain evidence that links training courses and curricula in training institutions with the industrial sector's requirements. In addition to developing and improving this relationship according to the requirements of the changing labor market. It is also possible to target different specializations according to the requirements of a different job and study them to develop the link between a specialization in training institutes and the requirements of a job in the labor market. Many private companies operating in the petrochemical and other industrial fields work in Jubail Industrial City. These companies and plants attract qualified national professional cadres, which require the technical institutes to link their training courses and curricula with the available jobs. [24] One of the direct results of strengthening this connection is an increase in the employment rate of graduates from the targeted specializations whose connection has been improved. Improving this connection also helps raise the quality of training courses and their programs. Indirect results include improving spending efficiency, increasing return on investment, and reducing waste of resources. Systematic and future-oriented curriculum updates can be an important lever of education-related innovation policies, and the education system, can strongly contribute to accelerating the diffusion of new technologies into mainstream firms by systematic and timely curriculum updates. [25]. The method used in this research helped extract the most important skills required and limit them to a small number (three skills) to focus their targeting in the courses, ensure their coverage, and allow students to practice

performing and acquiring the skills. The use of CTQ increased the clarification of what these skills are for training institutes, which helped in understanding them and thus increasing the possibility of improving courses and training programs. Using a cause and effect matrix, allows estimating the correlation between the main skills required and the training program courses. A comparison was also made between the weight of the courses versus the main skills required. The results were as expected, given that the specialization which was originally established on the basis of the requirements of the industrial sector in Jubail Industrial and other industrial complexes. Therefore, the results confirmed what was expected of the great compatibility between the requirements of the industrial sector and the outputs of the process operation training courses and program. Vocational education improves employability both in the short and medium run. [26] This was confirmed by the fact that the employment rate of graduates at the Jubail Technical Institute in general reached (88%) in the year 2020, as the highest employment rate in the Kingdom of Saudi Arabia among government higher education institutions [27]. Generally, the study presented a new model for how to estimate the connection between the requirements of the industrial sector through their job advertisements and training courses and programs. This is done by using possible tools such as (text mining) and verification via Excel software to extract the most important required skills. Then use CTQ and finally cause and effect matrix to detect and develop the connection between requirements and courses.

6. Conclusion

The results in this research were summarized in several points, including that the main skills required in the jobs of process operators and technicians are: operating, monitoring, inspecting and recording equipment data, complying with safety rules and regulations, following safety procedures and ensuring the safety of employees, operating the plants, conducting operating activities and verifying operational parameters, and troubleshoot plant operation. The results clarified some requirements in training courses that help achieve skills acquisition, such as the minimum number of training contact hours for each major needed skill by the industrial sector. The minimum equipment or experiments required for training. The results highlighted the concentration of skills required by the industrial sector in the most important training courses in the field of plant operation. Such as the number of courses that affected the operation, monitoring, inspection and recording of equipment data, plant operations, conducting operating activities, verifying operational parameters, troubleshooting plant operation and adhering to safety rules and regulations. This was done by using a new method as a model that can be developed using artificial intelligence tools. Throughout developing linking announcements issued periodically by the industrial sector in a specific field, for example, and tracking and linking it with training courses and program. As was done in the research, and used CTQ and cause and effect matrix tools to reach a faster evaluation that demonstrates opportunities for continuous improvement in training courses as inputs to meet the customer requirements in the industrial sector.

Limitation

This research was worked within the framework of a model to link the requirements of the industrial sector with training courses and program. The research did not aim to evaluate specific courses and prefer them over others. This research, as stated in its objective, is considered to study the extent to which the requirements of process technicians and operators are met by vocational and technical training institutions through the adoption of useful industrial curricula that are closely related to the targeted industrial sectors.

Compliance with ethical standards

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No conflict of interest to be disclosed.

References

[1] M. A. M. SALLAM, "The Role of the Manufacturing Sector in Promoting Economic Growth," vol. Vol 8 , no. No 7 , 2021.

[2] I. A. A. a. M. A. Almoree, "The relationship between," Journal of Economic Studies, vol. Vol. 45 No. 4, pp. 674-690, 2018.

[3] T. A. a. M. F. H. Mahmood, "Industrialization, urbanization and CO2 emissions in Saudi Arabia:," Energy Reports, pp. 1553-1560, 2020.

[4] A. Ali, "Industrial development in Saudi Arabia: disparity in growth and development," Problems and Perspectives in Management, vol. 18, no. 2, pp. 23-35, 2020.

[5] A. H. A. Alzalabani, "Antecedents of Job Satisfaction in Saudi Arabia: Impact of Industrial," International Journal of Business and Management, vol. 12, no. 11, pp. 61- 72, 2017.

[6] H. A. H. Esmail, "Economic Growth of Saudi Arabia Between Present and Future," Asian Social Science, vol. 14, no. 12, pp. 192- 201, 2018.

[7] M. Ö. a. H. E. SUNA, "Future of Vocational and Technical Education in Turkey:," Journal of Education and Humanities, vol. 10 , no. 20 , pp. 166-192, 2019.

[8] A. E. M.M. E. Ahmed, "The importance of Training on Engineering Control of Hazardous Materials Using Pilot Plant," SUST Journal of Engineering and Computer Sciences, vol. 20, no. 1, pp. 64-71, 2019.

[9] J. E. E. a. R. O. Owenvbiugie, Problems of Education In The 21st Century, vol. 75, pp. 535-549, 2017.

[10] M. O.-E. a. U. Renold, "No experience, no employment: The effect of vocational education and," Economics of Education Review, vol. 80, pp. 1-33, 2021.

[11] H. Ayub, "Parental Influence and Attitude of Students towards," International Journal of Information and Education Technology, vol. 7, no. 7, pp. 534- 538, 2017.

[12] T. K. Murgor, "Relationship between Technical and Vocational Acquired Skills," Journal of Education and Practice, vol. 4, no. 19, pp. 77- 83, 2013.

[13] A. B. D. a. K. W. B. Kagara, "BRIDGING THE MISSING. LINKS IN. THE IMPLEMENTATION. OF," Asia Proceedings of Social Sciences, vol. 6, no. 2, pp. 159-163, 2020.

[14] J. R. W. Hartwell C. Herring III, "The role of objectives in curriculum," Journal of accounting Education, vol. 18, no. 1, pp. 1-14, 2000.

[15] S. S. M. a. B. Umar, "Technical and Vocational Education and Training for Job Creation in," International Journal of Business and Administrative Studies, vol. 4, no. 1, pp. 21- 30, 2018.

[16] A. R. a. O. H. Janne Pietilä, "Process Operator Skill Exploration," in 18th World Congress, The International Federation of Automatic Control, Milano, 2011.

[17] R. Iliffe, "Technicians," Notes and Records of Royal Society, vol. 62, pp. 3- 16, 2008.

[18] A. Shepherd, "ISSUES IN THE TRAINING OF PROCESS OPERATORS," International Journal of Industrial Ergonomics, vol. 1, pp. 49- 64, 1986.

[19] H. Yudiono, "The alignment of productive competence on machinery between vocational," World Transactions on Engineering and Technology Education, vol. 15 , no. 3, pp. 256- 259, 2017.

[20] B. R. P. Shrestha, "VOCATIONAL EDUCATION AND TRAINING GRADUATES: CHALLENGES IN," International Journal of Social Science and Management, vol. 3, no. 3, pp. 141-145, 2016.

[21] M. A. Z. a. N. H. A. S. Hassan A. Al Abdullah, "Assessment of the Quality of Job Descriptions of Safety," Journal of Safety Studies, vol. 4, no. 1, pp. 1- 18, 2018.

[22] A. L. a. P. G. Chiara Cimini, "The evolution of operators' role in production: how," International Journal of Production Research, vol. 61, no. 24, p. 8493–8511, 2023.

[23] S. M. P. Y. S. N. a. W. S. Hasan Mahbub Tusher, "Operator Training for Non-Technical Skills in Process Industry," in 30th European Symposium on Computer Aided Chemical Engineering, volume 48, Milan, Italy, Elsevier, 2020, pp. 1993-1998.

[24] A. A.S. Al-Dossary, "Comparison of the Absence of the Trainees in Quarter and Semester Systems," Arab Journal for Scientific Publishing, no. 17, pp. 346-362, 2020.

[25] T. Schultheiss and U. Backes-Gellner, "Does updating education curricula accelerate technology adoption in the workplace? Evidence from dual vocational education and training curricula in Switzerland," The Journal of Technology Transfer, 2022.

[26] E. E. AS Al-Dossary, "Impact of English Language on GPA, Training Delay Time, and Attrition Rate in the Technical Institutes," Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications, no. 28, pp. 1-22, 2020.

[27] HRDF, "2019 graduates from public universities and their employment in the labor market until 2020," Saudi Human Resources Development Fund, 2020.