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PAPER

Integration of a Mobile-Based Smart Measurement System to Assess the Level of Work Readiness of Vocational Students in Higher Education

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ABSTRACT

This study aims to develop and evaluate a mobile-based intelligent measurement system as a tool to assess work readiness and identify work readiness patterns among vocational students in facing the challenges of Industry 4.0. Through the development of this innovative system, we have successfully created a tool that can provide more accurate and efficient evaluations of students' work readiness. The results of the study indicate that adapting to technological advancements and current labor market demands is crucial in preparing vocational graduates to succeed in an increasingly competitive workforce. It is hoped that these findings will contribute to improving the quality of vocational education and ensuring that graduates possess the relevant skills needed by the industry. In conclusion, this study not only offers practical solutions to enhance the work readiness of vocational students but also contributes to our understanding of vocational education in the Industry 4.0 era.

KEYWORDS

smart measurement system, work readiness, expert system, vocational education

1 INTRODUCTION

Vocational education aims to nurture skills, knowledge, attitudes, and work habits to ensure graduates are ready for employment [1–3]. However, open unemployment rates for graduates of vocational education in Indonesia remain relatively high. According to the Central Bureau of Statistics (BPS), the number of educated unemployed in Indonesia rose to 11.85% from 8.40 million people in 2022 [4], predominantly from vocational backgrounds [5]. The elevated unemployment rate can be attributed in part to a disparity in skills between graduates and the requirements of the job market [6], [7]. Graduates often lack the necessary skills to enter the workforce, leading to their unpreparedness for the job market.

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Ensuring graduates can effectively compete in the job market necessitates possessing work readiness, which denotes the mastery of knowledge, skills, and work attitudes. This proficiency enables graduates to perform tasks immediately without requiring further training [8]. It encompasses the skills, knowledge, and attitudes necessary for graduates to contribute effectively to organizational objectives in the workplace [9], [10]. It is crucial for educational institutions and employers to collaborate in identifying workforce needs and integrating them into educational curricula [11], [12]. Additionally, the development of non-technical skills such as interpersonal skills, adaptability, and problem-solving is also vital in enhancing graduates' work readiness.

Efforts to educate work-ready graduates are manifested through collaborative programs among the government, universities, industries, and the workforce, aiming to strengthen work ethics, attitudes, and students' adaptability to the work environment. One such initiative is the Industrial Field Practice (PLI) Program. However, the current PLI instrument's weakness lies in its inadequate representation of vocational students' work readiness [13], [14]. Existing measurement instruments for work readiness are often generic, failing to accurately assess vocational students' preparedness for the workforce [15], [16]. Hence, there is a need to formulate instruments capable of measuring graduates' work readiness accurately, such as the smart measurement system.

The smart measurement system is a mobile-based expert system capable of estimating the percentage of achievements yet to be attained by students. It serves as a guideline for students' work readiness by providing information on areas where they need to enhance their skills or knowledge to be better prepared for the workforce. The development of the smart measurement system involves collaboration across four different fields of expertise. To formulate a valid and reliable measurement instrument, collaboration is required from teams specializing in statistics measurement and industrial psychology under the umbrella of the faculty of psychology at universities. Meanwhile, the development of the intelligent system requires expertise in the fields of informatics and mathematics. Therefore, this study aims to create an expert system-based intelligent system to measure work readiness for vocational students. The following study questions are formulated to accomplish the study's objectives:

1. How are the development results of the mobile-based smart measurement system for vocational students?
2. How are the results of the confirmatory factor analysis of the mobile-based smart measurement system for vocational students?

2 METHODOLOGY

The 4D model is a study and development framework consisting of four stages [17]: "define," "design," "development," and "disseminate." This study produced a mobile-based smart measurement system capable of measuring work readiness.

The population of this study consists of final-year students from the Department of Electronics Engineering, encompassing five study programs: Information Engineering Education, Non-Education Informatics, Electronics Engineering Education, Animation, and System Engineering and Electronics Technology, who have completed or are undergoing industrial fieldwork during the academic year 2023–2024. Ensuring graduates can effectively compete in the job market necessitates possessing work readiness, which denotes the mastery of knowledge, skills, and work attitudes. This proficiency enables graduates to perform tasks immediately without requiring further training [18], [19]. Purposive sampling involves selecting study objects that can provide information in line with the studied desired criteria [19–22]. The primary criterion in sample selection for this study is respondents' willingness to participate by completing an online questionnaire. A total of 581 students participated in this study.

The study and development stages consist of four phases:

1. Define: This stage is where studied establish the study objectives, identify the problems to be addressed, and gather the initial information needed to design the system or product to be developed. During this phase, studied also set parameters and success criteria for system development.
2. Design: The stage of creating the initial system design based on the information obtained in the definition stage. This includes planning the system structure, user interface, and algorithms to be used in the system. Additionally, this stage involves developing initial prototype designs for inspection and evaluation.
3. Development: The stage in which the actual system is constructed based on the design formulated in the preceding stage. The development team initiates the implementation of the design into code and conducts phased testing of the system to verify that the desired functionalities operate correctly.
4. Disseminate: The stage where the developed system is introduced to the intended users. This includes product launches, user training, and disseminating information about the system to stakeholders. The objective of this phase is to verify that the system is operational and delivers the anticipated benefits.

The 4D model is depicted in Figure 1 below.

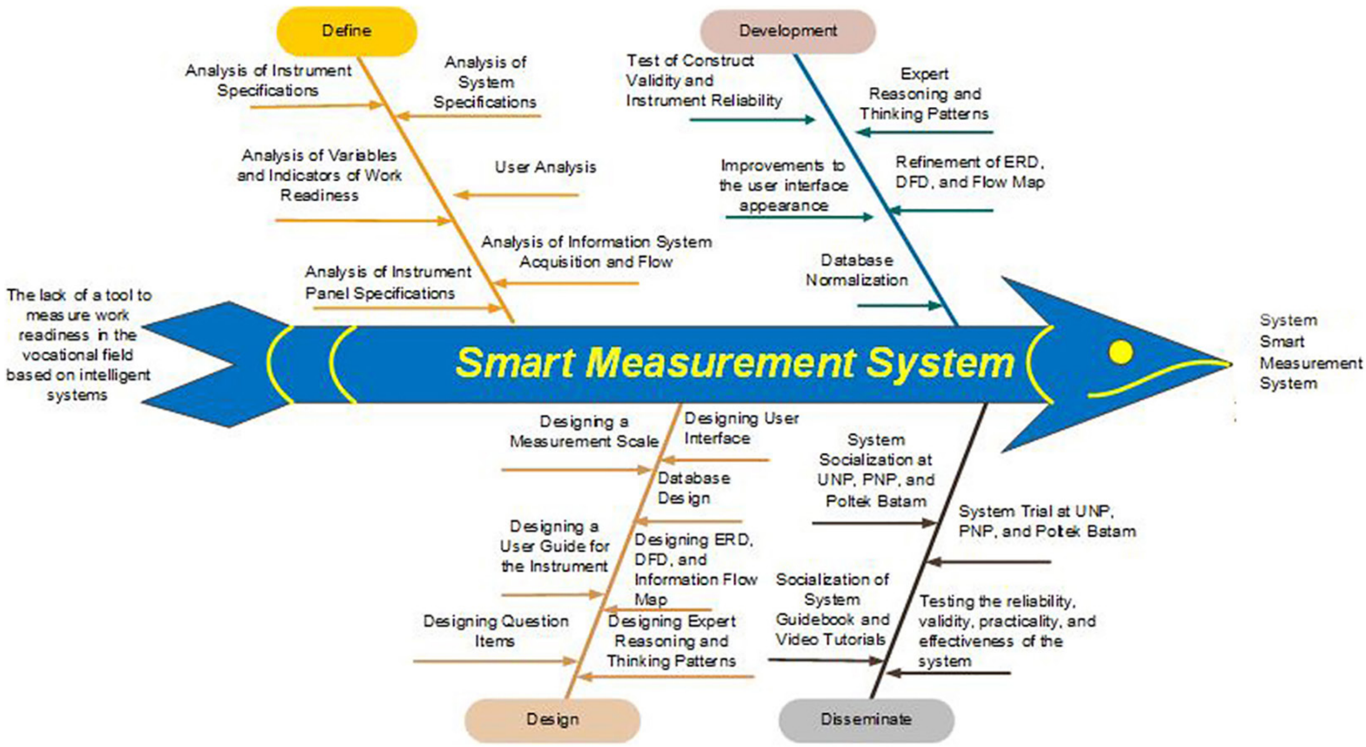

Fig. 1. 4D Instructional design model

The study instrument employed a questionnaire assessed on a 6-point Likert scale, ranging from 0 = very inappropriate; 1 = inappropriate; 2 = slightly inappropriate; 3 = neutral; 4 = appropriate; and 5 = very appropriate. The instrument was validated by three experts in the field of psychology and two experts in psychometrics. During the Focus Group Discussion (FGD), indicators and attributes were developed for each indicator while considering language structure. Valid measurement ensures its function is executed accurately and reliably. The system underwent validation testing by five experts before being used by 581 students from the Department of Electronics Engineering via Google Form for data collection.

Confirmatory factor analysis was employed to assess whether the observed variables could accurately and consistently account for the phenomena [23]. In interpreting the analysis results, a factor loading (λ) of ≥ 0.30 was considered significant [24], construct reliability (CR) of ≥ 0.70 [25], and variance extracted (VE) ≥ 0.50 [26]. Model fit was assessed using various indicators, including Minimum Fit Function Chi-Square (Significance Value), Root Mean Square Error of Approximation (RMSEA), Normed Fit Index (NFI), Non-Normed Fit Index (NNFI), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), and Adjusted Goodness of Fit Index (AGFI). Confirmatory factor analysis was performed using the LISREL 8.51 software for Windows.

3 RESULT AND DISCUSSION

3.1 User analysis

This study has resulted in the development of a mobile-based smart measurement system for vocational students. Simply providing recommendations and career matching is not sufficient to ensure the success of graduates in their careers. Such measures only serve to reduce the unemployment rate of higher education institutions by 45.20%. The consequence is the low level of company satisfaction with the performance of graduates. Vocational graduates often fail to adequately prepare for work, resulting in suboptimal career paths.

3.2 State objectives

This study aims to develop a mobile-based smart measurement system, which serves as a valid, practical, effective, and reliable tool for evaluating the level of Work Readiness among vocational students. By employing expert system methodology, this system can emulate the intelligence, thinking patterns, and reasoning of experts in industrial and organizational psychology, as well as industry experts, in assessing the work readiness of vocational students [27], [28]. Additionally, the system can compare measurement results before and after vocational students engage in Industrial Field Practice (PLI), and provide recommendations to strengthen work readiness indicators that need improvement. With this system in place, it is expected to assist vocational students and industry supervisors in enhancing the quality of vocational students' work readiness.

3.3 Choosing, method, and media

The system developed is called the Intelligent Measurement System, and its feature in the application is the job readiness test. The main software and tools used in designing the Intelligent Measurement System are: a) Android Studio, a platform specifically designed to support Java and Kotlin programming languages, and it provides a built-in Android emulator to test applications directly on various virtual devices [29]; b) SQLite, a C programming library that provides a small, fully integrated disk-based database within the application [30].

The initial design stages of the smart measurement system development are depicted in the system design, which targets users who use Android devices to run the system. Figure 2 illustrates the overall design of the smart measurement system that can be operated remotely by users.

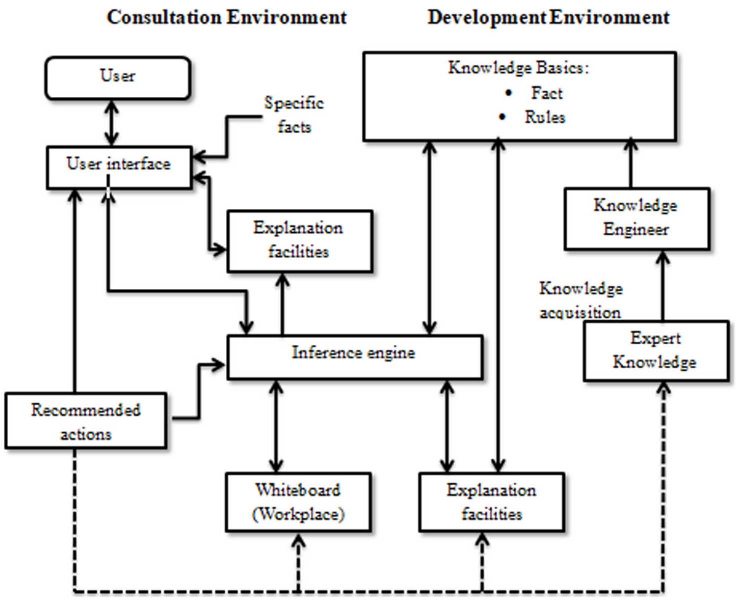

Fig. 2. The intelligent system architecture in the smart measurement system

Figure 2 presents a complex system design. To produce an accurate decision, the forward chaining strategy is used, where facts are used to test the truth value of hypotheses. Subsequently, the findings and interim conclusions are stored in a memory called "workplace," which then enters the explanation facility to explain the conclusions obtained to the user. Next, through the interface designed in the form of graphical results, these conclusions are presented attractively. The output generated by this system consists of recommendations to strengthen the indicators of work readiness that have not yet been achieved, thus providing guidance for improvement for students and supervisors to provide treatment to vocational students in the industry.

3.4 Utilizing media

Answer to RQ1: The impact of implementing the developed mobile-based smart measurement system

The smart measurement system offers significant benefits. It provides high validity for measuring the work readiness of vocational students, ensuring that the results obtained are reliable and useful for decision-makers. With expert system technology, the system can provide quick and efficient measurements, saving time for all parties involved [31]. Developed based on the knowledge and experience of experts, the smart measurement system can deliver measurements with high accuracy. Additionally, the system can monitor the development of students' work readiness over time and provide recommendations for improving readiness indicators. Therefore, the smart measurement system has the potential to significantly enhance the quality of vocational students' work readiness, helping them succeed in entering the workforce after graduation.

Figure 3 depicts the user interface of the system, designed with the following navigation: a) Home, serving as the main page of the system; b) About, providing a description and purpose of the system; c) Work Readiness, enabling user account creation for testing; and d) Login, for users to access their respective portals.

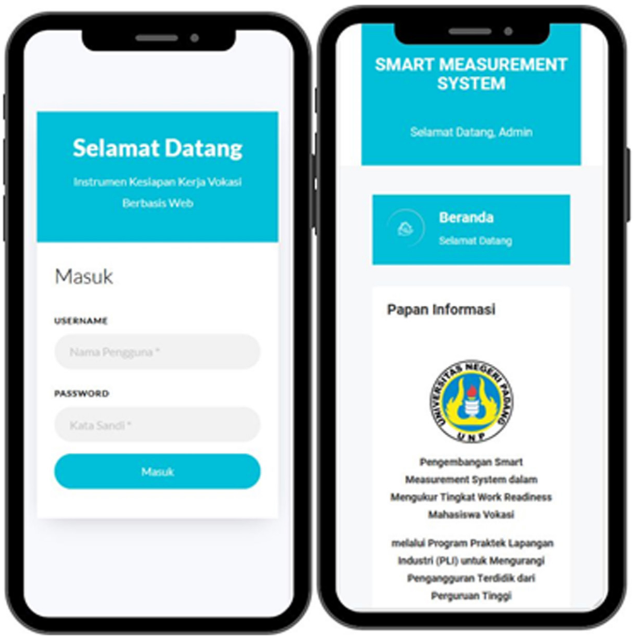

Fig. 3. The main menu of the smart measurement system

In Figure 4, the main menu of the smart measurement system is the "work readiness test." This feature is designed to allow users, such as students or industry mentors, to conduct testing or evaluation of vocational students' readiness for work. In other words, the "work readiness test" is part of the system's core function that enables users to measure and evaluate students' work readiness, which can then be used as a basis for providing recommendations or further actions to improve the quality of their work readiness.

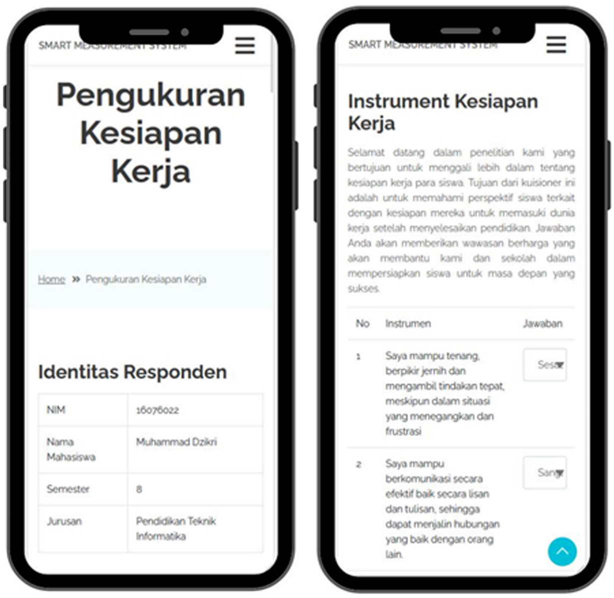

Fig. 4. Work readiness assessment page

Figure 5 presents the test question management page accessible to experts. This page is designed to facilitate experts in managing and composing various types of questions that will be used in the "work readiness test" within the smart measurement system. On this page, experts can create, edit, delete, or organize these questions according to the needs and objectives of work readiness measurement. Additionally, this page also provides an easy way for experts to organize questions based on topics, difficulty levels, or types of skills being assessed. Thus, the test question management page by experts is an integral part of the system that facilitates the process of developing and composing work readiness tests more efficiently and effectively.

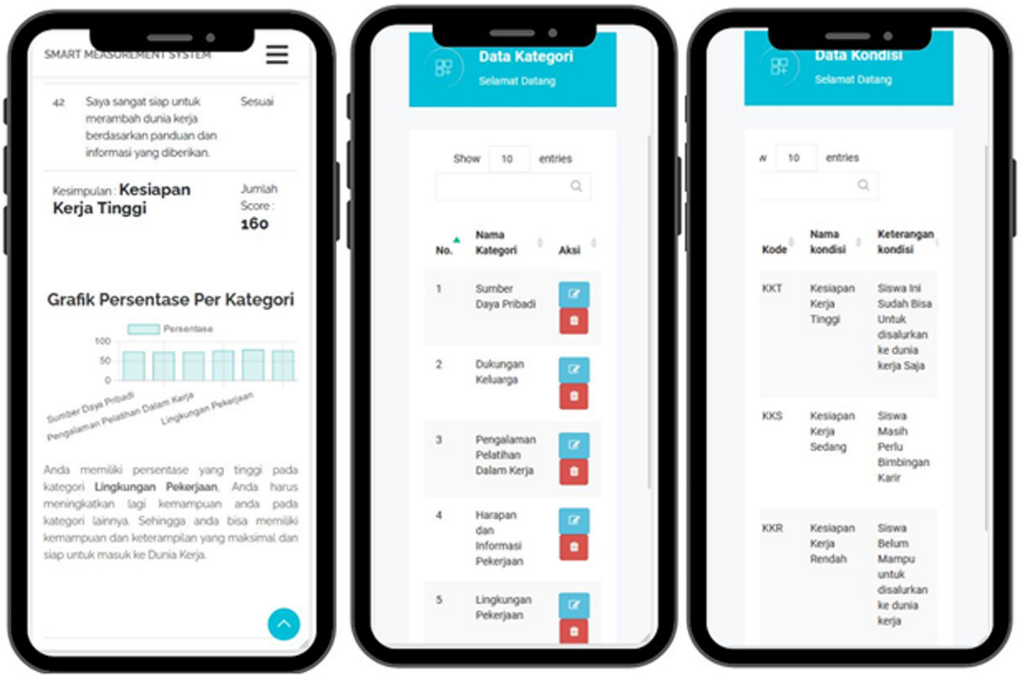

Fig. 5. The work readiness test management page

3.5 The results of the confirmatory factor analysis

Answer to RQ2: The results of the confirmatory factor analysis from the smart measurement system?

The suggested measurement model for graduate work readiness encompasses 42 attributes, organized into six constructs. Descriptive statistical analysis indicates that, overall, final-year students generally perceive work readiness attributes falling within the agree and strongly agree categories. Emotional control, good habits, job expectations, work attitude and professionalism, and optimism emerge as the top five attributes with the highest average scores. In contrast, learning support, introduction to the business sector, job searching, workplace simulation, and interpersonal relationships rank as the bottom five attributes with the lowest average scores (refer to Table 1).

Table 1. Summary of descriptive statistical and confirmatory factor analysis

Code	Work Readiness Attribute	Mean	SD	Loading Factor
Personal resources		4.430		0.82
PR1	Manage your emotions	4.698	0.591	0.53
PR2	Relationships between individuals	4.005	0.690	0.59
PR3	Capable of demonstrating maturity	4.596	0.581	0.73
PR4	Feeling optimistic	4.615	0.556	0.70
PR5	Capable of surmounting challenges	4.223	0.622	0.66
PR6	Possess the ability to adapt	4.378	0.670	0.65
PR7	Exert effort diligently	4.531	0.579	0.73
PR8	Capable of managing psychological stress	4.393	0.673	0.64
Family support		4.480	0.82	
FS1	Possess openness	4.424	0.767	0.69
FS2	Achieving self-actualization	4.529	0.600	0.77
FS3	Positive behavior	4.660	0.558	0.71
FS4	Assistance with learning	4.158	0.819	0.63
FS5	Fostering character development	4.462	0.677	0.69
FS6	Desire for employment	4.646	0.597	0.46
Experience gained through on-the-job training		4.578		0.82
IE1	Utilization of acquired knowledge	4.613	0.595	0.74
IE2	Employment competencies	4.552	0.615	0.82
IE3	Workplace demeanor and professionalism	4.624	0.558	0.85
IE4	Self-assurance	4.567	0.561	0.83
IE5	Drive to compete	4.505	0.598	0.80
IE6	Enhance readiness for employment	4.607	0.542	0.81
Anticipations regarding employment and related information		4.245		0.87
WI1	An overview of the business industry	4.143	0.791	0.70
WI2	An overview of various types of employment	4.174	0.737	0.74
WI3	Seeking employment	4.095	0.747	0.79
WI4	An introduction to the work environment	4.371	0.637	0.82
WI5	Choosing a job	4.359	0.643	0.83
WI6	Gathering information	4.198	0.726	0.75
WI7	Motivation for seeking information	4.376	0.654	0.82
Educational setting		4.283		0.84
LE1	Motivation for learning	4.349	0.659	0.78
LE2	Building competencies	4.297	0.725	0.85
LE3	Learning through practical experience	4.289	0.789	0.83

(Continued)

Table 1. Summary of descriptive statistical and confirmatory factor analysis *(Continued)*

Code	Work Readiness Attribute	Mean	SD	Loading Factor
LE4	Authentic experience	4.308	0.723	0.86
LE5	Professional autonomy	4.424	0.661	0.72
LE6	Learning through practical work experience	4.306	0.691	0.83
LE7	A simulated workplace	4.072	0.835	0.77
LE8	Extracurricular activities	4.220	0.737	0.60
Guidance for career development		4.225		0.83
CG1	Discovering interests and talents	4.241	0.724	0.82
CG2	Comprehension of the working environment	4.254	0.695	0.86
CG3	Personal potential enhancement	4.177	0.745	0.87
CG4	Self-reliant individuals	4.247	0.702	0.87
CG5	Advancement in the realm of employment	4.223	0.722	0.85
CG6	Planning for one's career	4.177	0.779	0.64
CG7	Preparedness for a career	4.256	0.675	0.66

According to Table 1, the components of work readiness encompass personal resources, family support, industrial work practice experience, job expectations and information, learning environment, and career guidance. Among these, industrial work practice experience has the highest average score (M = 4.578), with family support and personal resources following closely. Career guidance has the lowest average score (M = 4.225).

The standard solution for the confirmatory factor analysis is depicted in Figure 6, and Table 1 provides a summary of the analysis. The second factor analysis reveals that the factor loading values (λ) for each attribute range from 0.46 to 0.87. The attributes with the highest factor loadings are self-development, self-reliance, real work experience, understanding of the work world, and work attitude and professionalism. In contrast, the attributes with the lowest factor loadings are learning support, non-academic activities, interpersonal relationships, self-emotional control, and job expectations.

In the initial factor analysis, the factor loading values (λ) for each construct variable range from 0.82 (personal resources) to 0.87 (job expectations and information). All factor loading values exceed the cutoff value of 0.30. Additionally, the observed variables demonstrate construct reliability (CR) of 0.70 or higher, and the variance extracted (VE) values range from 0.43 to 0.65. Thus, it can be concluded that the variables used to assess graduate work readiness exhibit very good construct validity and reliability.

The model fit test is designed to assess how well the empirical data matches the model. The fit indices are as follows: minimum fit function chi-square = 3216.64 (P = 0.0); root mean square error of approximation (RMSEA) = 0.075; normed fit index (NFI) = 0.83; non-normed fit index (NNFI) = 0.85; goodness of fit index (GFI) = 0.78; comparative fit index (CFI) = 0.86; and adjusted goodness of fit index (AGFI) = 0.75. Based on these indices, it can be concluded that the model has a good fit between the empirical data and the estimated model. These results suggest that the measurement model, constructed from theoretical studies, is supported by empirical data.

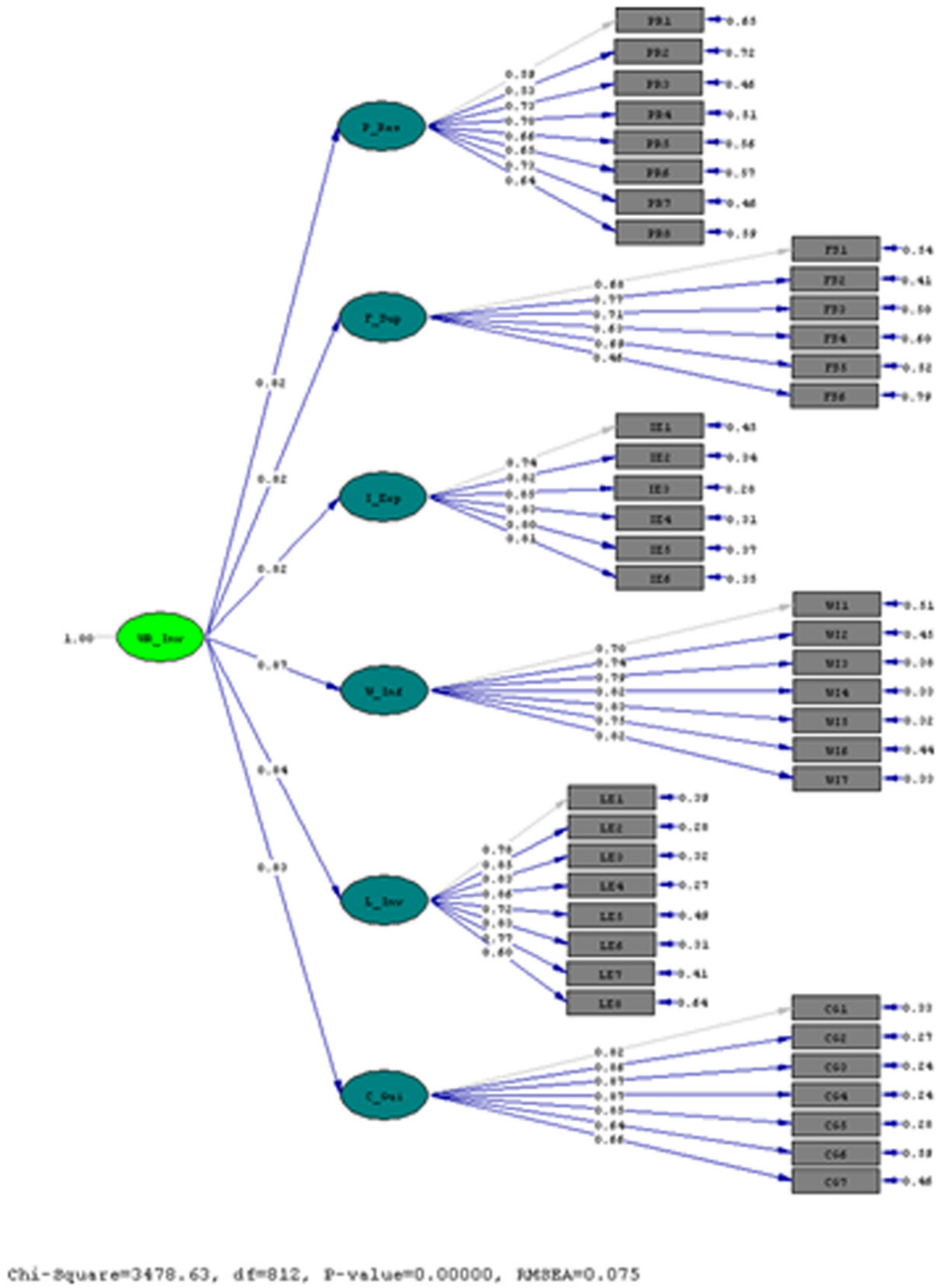

Fig. 6. Measurement model of graduate work readiness

Career guidance involves offering assistance to individuals so they can acquire the necessary knowledge, information, skills, and experience to investigate various career options, refine their choices, and make well-informed career decisions. Previous study, such as [32], focused on preparing accounting graduates for the challenges of the Industry 4.0 job market and updating the skill requirements for these graduates. Another study by [33] explored the use of data mining techniques to evaluate job readiness for entering or re-entering the workforce, employing the CRISP-DM methodology. Drawing from several similar study references aimed at preparing graduates for employment, studied developed a mobile-based the smart measurement system capable of measuring the work readiness level of vocational students. This innovative system represents a new opportunity for studied to advance expert systems as a solution for graduates [34], especially vocational students, addressing a gap in existing literature.

4 CONCLUSION

In summary, this study underscores the significance of devising innovative systems to assess the work readiness of vocational students in response to the challenges posed by Industry 4.0. Through the integration of methods such as data mining techniques and the development of expert systems, we have successfully crafted a mobile-based smart measurement system, facilitating a more precise and efficient evaluation of work readiness levels. Furthermore, this study illustrates that adequately preparing graduates, particularly in terms of cultivating skills pertinent to industry demands, necessitates a comprehensive and ongoing approach. By fostering collaboration among academics, industry professionals, and pertinent stakeholders, we are confident that the solutions identified in this study can significantly enhance the quality of vocational education and equip graduates for success in the dynamic workplace landscape. Consequently, this study not only addresses lacunae in academic discourse but also charts new pathways towards bolstering the work readiness of vocational students amidst this rapidly evolving era.

Additionally, the study findings emphasize the critical need to adapt to technological advancements and contemporary labor market requirements. The advent of Industry 4.0 has profoundly transformed the job landscape, necessitating vocational graduates to acquire pertinent and current skills to remain competitive in the increasingly challenging job market. With the implementation of the smart measurement system, vocational education institutions are anticipated to enhance their effectiveness in monitoring and evaluating students' work readiness, as well as in devising curricula that are aligned with industry demands. These measures will help ensure that vocational graduates possess the requisite skills demanded by the job market, thereby augmenting their prospects of securing suitable employment and making positive contributions to economic growth. Hence, the significance of this study extends beyond academia, offering practical solutions to future work readiness challenges.

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