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Interpretive Structural Modeling of Competency-Based Skill and Professional Training in the Ministry of Health, Treatment, and Medical Education

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A B S T R A C T

Purpose: The objective of this study was to develop and analyze an interpretive structural model of the key factors influencing the success of competency-based skill and professional training in the Ministry of Health, Treatment, and Medical Education.

Methods and Materials: This applied–developmental study employed a quantitative research design using the Interpretive Structural Modeling (ISM) approach. Data were collected in two stages: a comprehensive review of relevant national and international literature to identify the principal dimensions of competency-based training, followed by a field study using a structured expert questionnaire. Participants consisted of ten senior education managers with more than ten years of professional experience and specialization in educational management or human resource management. Expert judgments were used to construct the Structural Self-Interaction Matrix, which was then transformed into the initial and final reachability matrices. Hierarchical levels of variables were determined through iterative partitioning of reachability and antecedent sets. MICMAC analysis was subsequently applied to classify variables based on their driving and dependence power.

Findings: The results revealed that individual and developmental training functioned as the most influential driver of the system, while skill-based and clinical training emerged as the most dependent outcome. Professional and ethical training occupied a critical mediating position, and managerial and organizational training together with training based on emerging technologies served as dynamic linkage variables transmitting influence across the system. The MICMAC analysis indicated strong interdependence among all components, with no autonomous variables identified, reflecting a highly integrated competency-based training structure.

Conclusion: The findings demonstrate that sustainable improvement in competency-based professional training depends on a coherent structural alignment between individual development, ethical formation, organizational leadership, technological integration, and clinical competence, offering a strategic framework for guiding educational reform within the health sector.

Keywords: *Skill training; professional training; competency; clinical education; interpretive structural modeling; educational technology.*

1. Introduction

In recent decades, the paradigm of professional education has undergone a profound transformation as competency-based education (CBE) has increasingly replaced traditional content-driven and time-based instructional models. This transformation reflects the growing recognition that professional effectiveness in complex service systems, particularly in healthcare and education, depends not merely on knowledge acquisition but on the integrated development of skills, professional values, decision-making capacity, ethical judgment, and adaptive expertise (Frank et al., 2020; Frank et al., 2022; Frenk & Chen, 2024). Within this evolving global discourse, competency-based medical and professional education has emerged as a dominant framework for preparing practitioners capable of responding to rapidly changing societal needs, technological advancement, and increasing accountability requirements (Kohrt & et al., 2025; Sultan et al., 2025).

The conceptual foundations of competency-based education emphasize outcome-oriented training, mastery learning, learner-centered progression, and explicit performance standards. Rather than organizing curricula around disciplinary content, CBE structures learning around demonstrable professional competencies that are continuously assessed and progressively refined (Frank et al., 2020; Ten Cate, 2021). This shift has been reinforced by international policy frameworks advocating the alignment of education systems with labor market demands, health system priorities, and societal expectations of professional responsibility (Frenk & Chen, 2024; Spanakis et al., 2025). As health systems worldwide confront workforce shortages, technological disruption, and escalating service complexity, the necessity of robust competency-based training models has become increasingly evident (Kohrt & et al., 2025; Sultan et al., 2025).

Within healthcare education specifically, the competency-based movement has gained strong institutional support, driven by concerns over patient safety, quality of care, and professional accountability. Research demonstrates that graduates of competency-based programs exhibit stronger clinical performance, enhanced problem-solving abilities, and improved adaptability to real-world practice conditions (Liaw & et al., 2025; Nagai et al., 2024). Competency-based approaches facilitate the systematic development of clinical judgment, communication skills, ethical reasoning, teamwork, leadership, and digital literacy—competencies now considered indispensable for contemporary health professionals (Norman et al., 2025; Spanakis et al., 2025). These developments have elevated competency-based education from a pedagogical innovation to a strategic imperative in healthcare systems globally (Frenk & Chen, 2024; Kohrt & et al., 2025).

Despite its widespread endorsement, the implementation of competency-based education presents significant structural and organizational challenges. Transitioning from conventional education models requires fundamental changes in curriculum design, assessment systems, faculty roles, institutional culture, and governance mechanisms (Frank et al., 2022; Ten Cate, 2021). Successful implementation depends not only on instructional redesign but on the alignment of organizational structures, leadership practices, resource allocation, and professional development strategies (Norman et al., 2025; Whitty, 2024). Empirical evidence indicates that many institutions struggle with fragmented reforms, lack of coordination among stakeholders, and insufficient integration between policy and practice (Gandomkar & et al., 2023; Vakilzadeh et al., 2023).

These challenges are particularly pronounced in national health education systems undergoing large-scale reform. In Iran, the Ministry of Health, Treatment, and Medical Education has formally adopted competency-based training as a core policy priority, recognizing its central role in improving healthcare quality and workforce effectiveness (Iran, 2022). However, translating strategic intent into operational reality remains complex. Studies conducted within the Iranian health education system reveal persistent gaps between policy frameworks and institutional practice, especially in areas of curriculum coherence, assessment alignment, faculty preparedness, and technological integration (Bahrevar et al., 2024; Gandomkar & et al., 2023; Vakilzadeh et al., 2023). These findings underscore the necessity of systematic models capable of organizing the multiple dimensions of competency-based training into coherent, actionable structures.

One of the most critical limitations of existing reforms is the absence of integrative models that explicitly clarify the interrelationships among various components of competency-based education. While numerous studies have identified individual dimensions of competency-based training—such as clinical skills, professional ethics, leadership development, digital competence, and faculty capacity—few have offered comprehensive structural frameworks that explain how these dimensions interact to produce sustainable educational outcomes (Assadisharif et

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al., 2024; Bahrevar et al., 2024; Norman et al., 2025). Without such structural clarity, reform initiatives risk fragmentation, inefficiency, and limited impact.

Emerging research further emphasizes that effective competency-based training must extend beyond technical skill acquisition to encompass ethical formation, professional identity development, organizational competence, and continuous personal growth (Sukma, 2025; Whitty, 2024; Романов & Romanova, 2024). In health professions education, ethical competence and professional values are now recognized as foundational to safe practice, patient trust, and system integrity (Assadisharif et al., 2024; Spanakis et al., 2025). Similarly, managerial and organizational competencies among educators and administrators play a decisive role in enabling institutions to sustain high-quality competency-based programs (Norman et al., 2025; Vakilzadeh et al., 2023).

Technological transformation has added an additional layer of complexity and opportunity to competency-based training systems. Innovations such as advanced simulation, virtual reality, augmented reality, artificial intelligence-driven assessment, and digital learning platforms are reshaping professional education worldwide (Liaw & et al., 2025; Spanakis et al., 2025). Evidence suggests that technology-enhanced competency development significantly improves learning outcomes, clinical readiness, and learner engagement when properly integrated into pedagogical and organizational frameworks (Liaw & et al., 2025; Sultan et al., 2025). However, technology adoption without structural alignment often produces superficial change rather than meaningful educational transformation (Kohrt & et al., 2025; Norman et al., 2025).

International comparative studies reinforce the conclusion that competency-based education succeeds only when supported by coherent governance structures, faculty development systems, assessment architectures, and continuous feedback mechanisms (Frank et al., 2022; Frenk & Chen, 2024; Ten Cate, 2021). Countries that have achieved sustained improvements in professional competence have implemented multi-level reform strategies that integrate policy, institutional leadership, curricular design, faculty roles, and learning technologies (Spanakis et al., 2025; Tveitnes et al., 2025; Whitty, 2024). These experiences highlight the importance of systems thinking in educational reform.

From a methodological perspective, modeling such complex interdependencies requires analytical approaches capable of capturing both hierarchical relationships and reciprocal interactions among system components. Interpretive Structural Modeling (ISM) offers a powerful methodological framework for this purpose by enabling researchers to identify key variables, structure their interrelationships, and construct hierarchical models that reveal underlying system dynamics. ISM has been successfully applied across domains including education, management, healthcare systems, and organizational development to clarify complex decision environments and guide strategic planning (Kohrt & et al., 2025; Norman et al., 2025). By translating expert knowledge into structured models, ISM provides actionable insights for policymakers and institutional leaders.

Within the context of Iran's health education system, the need for such a structural modeling approach is particularly urgent. National policy documents emphasize the development of competency-based education as a cornerstone of healthcare reform, yet implementation remains uneven and conceptually fragmented (Gandomkar & et al., 2023; Iran, 2022). Institutional leaders require clear roadmaps that specify which components of competency-based training exert the greatest influence, how they interact, and where reform efforts should be prioritized. Without this structural clarity, reform initiatives risk dissipating resources and failing to achieve sustainable impact.

Furthermore, global evidence increasingly supports the argument that the success of competency-based systems depends not on isolated interventions but on the coherent alignment of individual development, ethical formation, organizational leadership, technological integration, and professional skill-building within a unified structural framework (Assadisharif et al., 2024; Bahrevar et al., 2024; Norman et al., 2025; Романов & Romanova, 2024). This alignment requires systematic modeling approaches capable of revealing the deep architecture of educational systems rather than merely describing surface-level components.

Against this theoretical and practical backdrop, the present study addresses a critical gap in the literature by developing an interpretive structural model of competency-based skill and professional training within the Ministry of Health, Treatment, and Medical Education. By integrating perspectives from educational management, professional development, technological innovation, and health policy, this research seeks to provide a comprehensive framework that supports evidence-based decision-making and strategic reform.

Accordingly, the aim of this study is to develop an interpretive structural model of the key factors influencing

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the success of competency-based skill and professional training in the Ministry of Health, Treatment, and Medical Education.

2. Methods and Materials

2.1. Study Design and Participants

The present study was designed as an applied–developmental research project with a quantitative methodological orientation, employing the Interpretive Structural Modeling (ISM) approach as its primary analytical framework. The research sought to develop a structured model of competency-based skill and professional training within the organizational context of the Ministry of Health, Treatment, and Medical Education. Given the exploratory and system-structuring nature of the research objective, ISM was selected as the most appropriate method to identify complex interrelationships among key training dimensions and to establish a hierarchical model of influence and dependence. The field participants consisted of ten senior education managers selected through purposive expert sampling. All participants possessed more than ten years of professional experience in the domain of education management and held academic specialization in either educational management or human resource management. The selection criteria ensured that respondents had both theoretical knowledge and extensive practical exposure to professional and competency-based training systems, thereby strengthening the validity of expert judgments elicited during the modeling process.

2.2. Data Collection

Data were collected through a two-stage process that integrated documentary analysis with field-based expert inquiry. In the first stage, an extensive review and exploration of relevant national and international literature, policy documents, and empirical studies were conducted to identify core constructs and preliminary dimensions of competency-based skill and professional training. This conceptual foundation informed the development of the research instrument. In the second stage, a structured expert questionnaire was designed based on the identified constructs to capture the perceived relationships among the variables. The questionnaire was administered to the selected experts in face-to-face sessions, during which respondents were asked to evaluate pairwise relationships between factors according to the ISM symbolic logic (V, A, X, O). The design of the instrument enabled the systematic construction of the Structural Self-Interaction Matrix (SSIM), ensuring consistency and reliability in expert responses.

2.3. Data Analysis

Data analysis was conducted using the Interpretive Structural Modeling procedure. Initially, the SSIM was constructed from expert judgments and subsequently converted into the initial reachability matrix through binary transformation rules. Transitivity checks were then applied to obtain the final reachability matrix, from which the driving power and dependence power of each variable were calculated. The hierarchical levels of the variables were determined through iterative partitioning of reachability and antecedent sets, resulting in the final structural model of the system. To further examine the structural characteristics of the model, MICMAC analysis was employed to classify variables into autonomous, dependent, linkage, and independent clusters based on their influence and dependence properties. This combined analytical approach provided a comprehensive understanding of the underlying structure governing the success of competency-based skill and professional training within the studied institutional context.

3. Findings and Results

To determine the type of relationships among the variables, the following symbols were used:

V: Factor *i* leads to the achievement of column factor *j*.

A: Column factor *j* leads to the achievement of row factor *i*.

X: Both the row and column factors influence each other.

O: There is no relationship between the row and column factors.

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Table 1

Structural Self-Interaction Matrix (SSIM)

I \ J	C1	C2	C3	C4	C5
C1 Skill-Based and Clinical Training	X	X	A	O	O
C2 Professional and Ethical Training		X	O	A	X
C3 Managerial and Organizational Training			X	O	X
C4 Individual and Developmental Training				X	O
C5 Training Based on Emerging Technologies					X

By converting the SSIM symbols into binary values, the initial reachability matrix is obtained. This matrix contains only zeros and ones. The transformation rules are as follows:

If the cell contains V, enter 1 in that cell and 0 in the symmetric cell.

If the cell contains A, enter 0 in that cell and 1 in the symmetric cell.

If the cell contains X, enter 1 in both the cell and its symmetric counterpart.

If the cell contains O, enter 0 in both the cell and its symmetric counterpart.

Table 2

Initial Reachability Matrix

I \ J	C1	C2	C3	C4	C5
C1	1	1	0	0	0
C2	0	1	0	1	1
C3	1	0	1	0	1
C4	1	1	0	1	0
C5	1	0	1	1	1

After constructing the initial reachability matrix, the final reachability matrix is generated to ensure consistency of the relationships. This matrix displays the *driving power* and *dependence power* of each variable. Driving power refers to the total number of variables (including itself) that a given variable can influence. Dependence power refers to the total number of variables that influence a given variable.

Table 3

Final Reachability Matrix

i \ j	C1	C2	C3	C4	C5	Driving Power
C1	1	0	0	0	1	2
C2	1	1	0	1	1	4
C3	1	0	1	1	1	4
C4	1	1	1	1	1	5
C5	1	0	1	1	1	4
Dependence Power	5	2	3	4	5	

The results indicate that the highest level of influence belongs to Individual and Developmental Training (driving power = 5), whereas the lowest level of influence belongs to Skill-Based and Clinical Training (driving power = 2).

To determine the hierarchical level of each factor in the final model, the *reachability set*, *antecedent set*, and *intersection set* were identified. The reachability set includes the factor itself and all factors it can reach. The antecedent set includes the factor itself and all factors that can lead to it. The intersection set consists of the common elements of the reachability and antecedent sets. If the reachability set and the intersection set for a factor are identical, that factor is placed at the highest level. The identified factor is then removed, and the process is repeated for the remaining factors until all factors are leveled. This procedure resulted in the identification of five hierarchical levels.

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Table 4

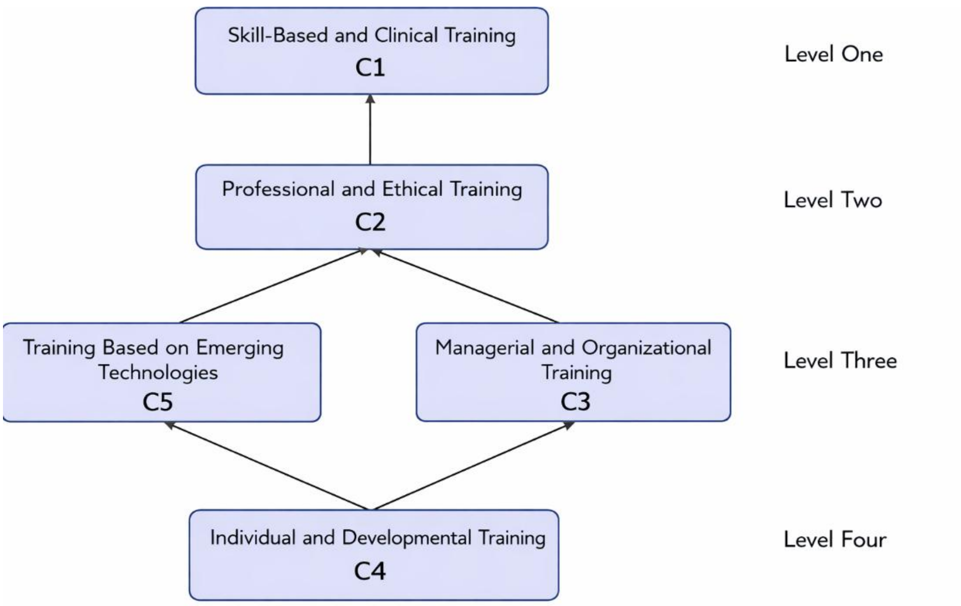
Determination of Variable Levels

Symbol	Variable	Level	Driving Power	Dependence Power
C1	Skill-Based and Clinical Training	1	2	5
C2	Professional and Ethical Training	2	4	4
C3	Managerial and Organizational Training	3	4	3
C4	Individual and Developmental Training	4	5	2
C5	Training Based on Emerging Technologies	3	4	5

First, based on the identified levels, the criteria were arranged from top to bottom according to their priority. Using the matrix obtained from the reachability matrix ordered by levels, the structural model was drawn by means of nodes and directed links. If a relationship existed from *i* to *j*, it was represented by an arrow from *i* to *j*. The final diagram, which was derived by eliminating transitive relationships and applying level partitioning, is illustrated in Figure 1.

Figure 1

Interaction Model of the Factors



Level one was identified as the most dependent level, and the last level as the most influential. As shown in the figure, the fourth-level factor (Individual and Developmental Training) functions as the foundational cornerstone of the model. Accordingly, the success model of competency-based skill and professional training in the Ministry of Health, Treatment, and Medical Education should begin with this variable and then extend to the remaining variables. The factors (Managerial and Organizational Training) and (Training Based on Emerging Technologies) are positioned at the third level and exert influence on the second-level factor. At the second level, the factor (Professional and Ethical Training) is located, which affects the first-level factor. The first-level factor is (Skill-Based and Clinical Training), which, by itself, does not influence the other factors.

The purpose of this analysis was to identify and examine the driving power and dependence power of the variables. After determining the driving and dependence powers, all factors can be classified into four clusters using the Cross-Impact Matrix Multiplication Applied to Classification (MICMAC) method (Godet, 2006). In the MICMAC matrix, the boundary values are typically considered to be one unit greater than the mean number of factors. In the present study, given that the number of factors was five, the boundary value on the MICMAC matrix was set at three. However,

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depending on the research context, different boundary values may be applied. The boundary values should be defined in such a way that the factors are clearly distinguished into the intended clusters.

Table 5

Driving Power and Dependence Power

Symbol	Driving Power	Dependence Power
C1	2	5
C2	4	4
C3	4	3
C4	5	2
C5	4	5

Based on their driving and dependence powers (Table 5), the variables were classified into four categories as follows.

Autonomous variables: These enablers possess weak driving power and weak dependence power. They are relatively disconnected from the system and have few linkages. These enablers are located in Quadrant I.

Dependent variables: This group includes enablers with weak driving power but strong dependence power and are located in Quadrant II.

Linkage variables: These variables have both strong driving power and strong dependence power and are positioned in Quadrant III. They are unstable; therefore, any action taken on them affects others and also generates feedback effects on themselves.

Independent variables: These variables have strong driving power but weak dependence power and are located in Quadrant IV.

Subsequently, the diagram of driving power versus dependence power for the criteria was constructed, as illustrated in Figure 2.

It can be observed that the highest scores are associated with "Training Based on Emerging Technologies." The row sums, column sums, and total scores of the factors are presented in Table 6.

Table 6

Total Scores of the Factors

Factor	Row Sum	Column Sum	Total Score
C1	2	5	7
C2	4	4	8
C3	4	3	7
C4	5	2	7
C5	4	5	9
Total	19	19	38

The ultimate objective of structural analysis is to identify the characteristics, structure, key variables, and the most important factors affecting the success of competency-based skill and professional training in the Ministry of Health, Treatment, and Medical Education. In the cross-impact matrix, the sum of the values in each row represents the active sum and indicates the degree of influence of that factor. Likewise, the sum of the values in each column represents the total of active and passive effects and indicates the degree of dependence of that factor.

Table 7

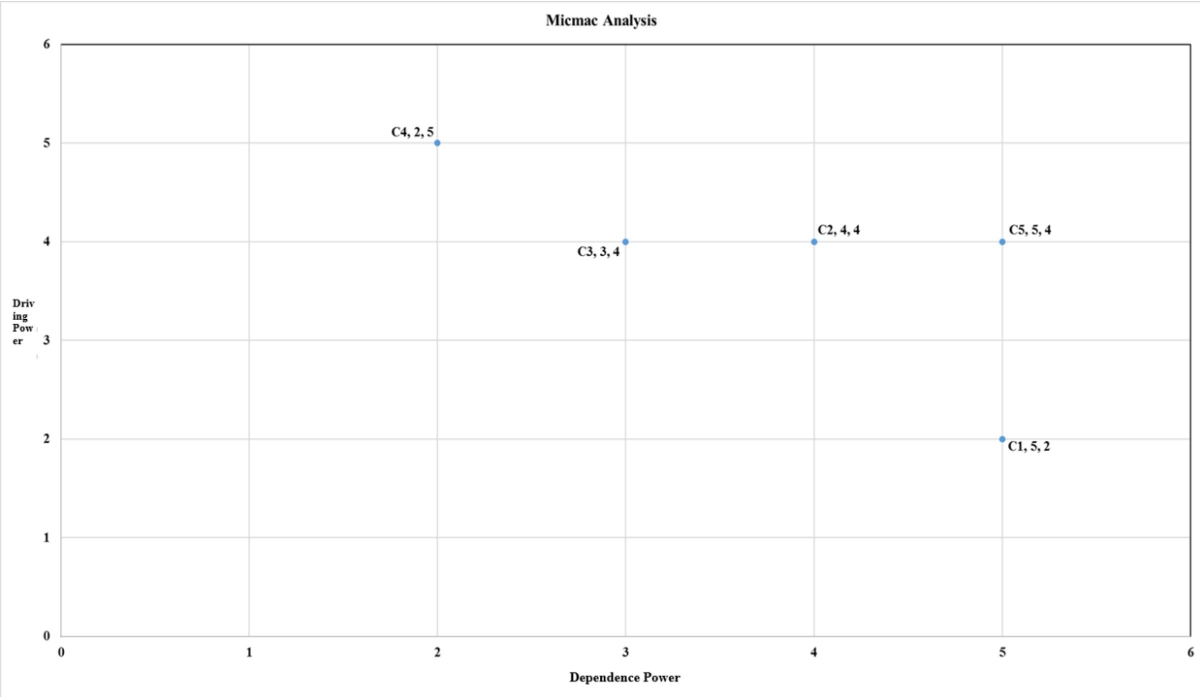
Summary of Cross-Impact Matrix Results

Index	Matrix Dimension	Number of Iterations	Number of 0s	Number of 1s	Number of 2s	Number of 3s	Total	Matrix Fill Rate
Value	5	4	1	16	39	34	90	95.98%

According to Table 7, the results of the cross-impact matrix calculations using MICMAC software indicate that the relationships among the factors were evaluated 90 times in total. Of these, one case showed no influence or dependence, 16 cases represented weak relationships and influence, 39 cases indicated moderate relationships and influence, and 34 cases reflected strong relationships and influence. The results of this section demonstrate that moderate influence had the highest frequency. The number of iterations was set to four, and the matrix fill rate was 95.98%, indicating that the selected factors exert moderate and dispersed effects on one another and that the system is somewhat unstable. The matrix, based on statistical indicators and after three rotations, achieved 100% adequacy and optimality, reflecting the high validity of the matrix and the corresponding responses.

Figure 2

Driving Power and Dependence Power of the Factors



The MICMAC analysis shows that no variable falls into the autonomous category (Group I). This finding indicates the existence of strong interrelationships among the components of the derived model and reflects the high driving power of the factors.

The variable "Skill-Based and Clinical Training" is most affected by the other factors and, from a systemic perspective, is classified as a dependent variable (Group II). It has weak driving power but a higher level of dependence compared with the other factors. In other words, this factor represents the output of interactions among the other factors. Indeed, more influential factors exist in the success model of competency-based skill and professional training in the Ministry of Health, Treatment, and Medical Education that lead to this factor.

The variables "Professional and Ethical Training," "Managerial and Organizational Training," and "Training Based on Emerging Technologies" are classified as linkage variables (Group III) in terms of both influence and dependence. This means that these variables possess strong driving power and strong dependence. These variables are non-static, because any change in them affects the entire system, and, ultimately, system feedback can also modify these variables again.

Moreover, the variable "Individual and Developmental Training" belongs to the group of independent variables. This means that few variables exert influence over it. These variables have strong driving and guiding power while simultaneously exhibiting weak dependence. Due to their extensive and strong connections with the system, they are fully integrated within it. Any change in these variables affects the entire system and may even lead to the disruption of internal linkages within the system.

4. Discussion and Conclusion

The present study developed an interpretive structural model of competency-based skill and professional training in the Ministry of Health, Treatment, and Medical Education and revealed a multi-level hierarchical structure consisting of four principal levels of influence and dependence. The

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findings demonstrated that individual and developmental training (C4) constituted the most influential foundational driver of the system, while skill-based and clinical training (C1) emerged as the most dependent outcome variable. Professional and ethical training (C2) occupied an intermediate mediating position, and both managerial and organizational training (C3) and training based on emerging technologies (C5) were positioned as critical linkage variables that transmit influence across the system. These results highlight the systemic nature of competency-based education and emphasize that sustainable improvement in clinical competence cannot be achieved through isolated curricular interventions but must be grounded in coherent structural alignment across personal, organizational, technological, and ethical dimensions.

The identification of individual and developmental training as the most influential driver is particularly significant. This finding indicates that the success of competency-based professional training is fundamentally rooted in continuous personal development, self-regulation, professional identity formation, motivation, and lifelong learning orientation. This result aligns closely with the theoretical foundations of competency-based education, which emphasize learner agency, reflective practice, and progressive mastery rather than passive content acquisition (Frank et al., 2020; Ten Cate, 2021). It is further supported by global evidence showing that sustained professional competence depends on systematic investment in individual growth, metacognitive skills, and adaptability (Frenk & Chen, 2024; Norman et al., 2025). The present findings thus reinforce the argument that without a strong foundation of individual development, organizational reforms and technological investments fail to translate into meaningful professional outcomes.

The placement of skill-based and clinical training as the most dependent factor indicates that clinical competence is the cumulative product of upstream influences rather than the starting point of reform. This finding is consistent with empirical studies demonstrating that clinical performance is shaped by educational climate, ethical orientation, leadership practices, faculty competence, and technological infrastructure (Assadisharif et al., 2024; Nagai et al., 2024). Sultan et al. (2025) similarly emphasize that community and clinical competence emerges from integrated systems of education, supervision, professional values, and organizational support rather than from procedural instruction alone (Sultan et al., 2025). The dependency of clinical training in the current model underscores the importance of addressing structural determinants before expecting improvements in frontline professional performance.

The intermediate role of professional and ethical training in the second level of the hierarchy reflects its function as a crucial mediating mechanism between foundational individual development and applied clinical competence. Ethical competence and professional identity formation serve as the moral and cognitive framework through which technical skills are interpreted and applied in real-world practice. This result corresponds with research showing that ethical reasoning and professional values significantly influence decision-making quality, patient trust, teamwork effectiveness, and institutional culture (Assadisharif et al., 2024; Whitty, 2024). Studies conducted in diverse professional contexts, including sports management and teacher education, likewise demonstrate that professional ethics functions as a stabilizing core that shapes both individual conduct and organizational coherence (Sukma, 2025; Романов & Romanova, 2024). Thus, the present model confirms that ethical formation is not peripheral but structurally central to competency-based training systems.

The classification of managerial and organizational training and training based on emerging technologies as linkage variables with both high driving power and high dependence indicates that these factors operate as dynamic transmission hubs within the system. Managerial competence shapes policy implementation, curriculum governance, faculty development, and resource distribution, while technological competence determines the effectiveness of modern learning environments, assessment systems, and simulation-based instruction. These results are strongly supported by existing literature. Vakilzadeh et al. (2023) emphasize that managerial competence within the Ministry of Health is a decisive factor in educational quality and institutional performance (Vakilzadeh et al., 2023). Similarly, Bahrevar et al. (2024) identify organizational capacity and leadership coherence as key determinants of successful skill-based training systems (Bahrevar et al., 2024). On the technological side, Liaw et al. (2025) demonstrate that advanced simulation, virtual reality, and digital platforms significantly enhance clinical competency development when properly embedded within pedagogical and organizational frameworks (Liaw & et al., 2025). The present findings confirm that neither management nor technology can function effectively in isolation; rather, their impact depends on their integration with individual development and ethical culture.

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The MICMAC analysis further revealed that no variables were autonomous within the system, indicating strong interdependencies among all components of the competency-based training model. This finding underscores the systemic nature of professional education reform. In line with systems theory and educational change literature, such interconnectedness implies that interventions targeting a single component are unlikely to produce sustainable improvement unless accompanied by complementary changes across the entire system (Frank et al., 2022; Frenk & Chen, 2024). The unstable nature of linkage variables identified in this study further highlights the importance of careful governance and continuous monitoring, as changes in managerial practices or technological infrastructure can generate cascading effects throughout the educational ecosystem (Kohrt & et al., 2025; Norman et al., 2025).

The model developed in this study also resonates strongly with the national strategic direction articulated by the Ministry of Health, Treatment, and Medical Education, which emphasizes competency-based education as a cornerstone of healthcare reform in Iran (Iran, 2022). However, prior research has documented persistent challenges in translating policy into practice, including fragmented curricula, insufficient faculty preparation, and limited technological integration (Gandomkar & et al., 2023). By clarifying the hierarchical structure and interdependencies among core training dimensions, the present model provides an empirically grounded framework to guide institutional leaders in prioritizing reform initiatives and allocating resources more effectively.

At the international level, the findings are consistent with comparative studies showing that countries achieving the greatest success in competency-based reform have adopted holistic strategies that integrate personal development, ethical formation, organizational leadership, and technological innovation within coherent governance structures (Spanakis et al., 2025; Tveitnes et al., 2025; Whitty, 2024). The current model contributes to this body of knowledge by offering a context-specific structural framework tailored to the Iranian health education system while retaining strong theoretical alignment with global best practices.

Overall, the results of this study extend existing theory by demonstrating that competency-based skill and professional training operates as a complex adaptive system in which individual development constitutes the primary driver, ethical formation provides normative coherence, managerial and technological capacities function as dynamic mediators, and clinical competence emerges as the final integrated outcome. This structural understanding provides both conceptual clarity and practical guidance for policymakers, institutional leaders, and educators seeking to design sustainable and effective competency-based training systems.

Despite its contributions, this study has several limitations. First, the sample size of experts was limited, although the use of highly experienced participants strengthened the validity of judgments. Second, the model reflects the specific institutional and cultural context of Iran's health education system and may require adaptation for other national settings. Third, the study relied on expert perceptions rather than direct measurement of training outcomes, which may introduce subjective bias.

Future research should test the proposed structural model using large-scale empirical data and quantitative validation techniques such as structural equation modeling. Comparative studies across different medical universities and international contexts could further refine the model's generalizability. Longitudinal research is also needed to examine how changes in individual development, organizational leadership, and technological capacity influence clinical competence over time.

Educational leaders should prioritize investment in individual and developmental training as the foundation of reform. Institutions should strengthen ethical and professional education as a core component of all training programs. Organizational leadership development and strategic technology integration must be treated as interconnected levers of change. Finally, continuous system-wide evaluation mechanisms should be established to monitor alignment between policy, practice, and professional outcomes.

Authors' Contributions

Authors equally contributed to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

All procedures performed in studies involving human participants were under the ethical standards of the institutional and, or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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