

International Journal of Urban Management and Energy Sustainability (IJUMES)

Homepage: <http://www.ijumes.com>



ORIGINAL RESEARCH PAPER

A Study on Fuzzy Cognitive Mapping to Analyze Factors that Impact the Model of Vitality Effects in University Educational Environments with a Focus on Promoting Students' Self-Actualization

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ARTICLE INFO

Article History:

Received 2025-09-09

Revised 2025-11-09

Accepted 2025-12-04

Keywords:

DPSIR model, fuzzy cognitive mapping, learning environments, PLS-SEM, self-actualization

DOI: [10.22034/IJUMES.2025.2077266.1343](https://doi.org/10.22034/IJUMES.2025.2077266.1343)

ABSTRACT

This Improving the quality of education and developing individual and collective talents requires university educational environments that serve as platforms for students' scientific and social growth. Despite the importance of this issue, accurate recognition of the factors affecting vitality and the complex interactions between them in the university environment still requires systematic and scientific research. Given this necessity, this study examines and analyzes the factors affecting the model of the effects of vitality in university educational environments, and the main goal of the study is to identify key factors affecting the increase in vitality and examine their role in promoting students' self-actualization. In this regard, the study, emphasizing the interaction between the dimensions of vitality and the educational environment, tries to provide a framework for the effective management of these factors. The research method is analytical and the purpose is applied. The method of collecting information is documentary and library. First, using the fuzzy cognitive mapping method, modeling of research components was carried out, and also in order to increase the accuracy of the analysis, the conceptual framework of the DPSIR model was combined with PLS-SEM model. The findings indicate positive bidirectional relationships between environmental and spatial components, negative bidirectional relationships with activity components, and negative unidirectional relationships with self-actualization. The results indicate that managing and strengthening social components, due to their greatest impact and influence over other factors, is vital for promoting students' self-actualization and improving vitality in educational environments.

Running Title: *The model of vitality effects in university educational environments*



NUMBER OF REFERENCES

18



NUMBER OF FIGURES

17



NUMBER OF TABLES

15

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INTRODUCTION

One of the essential needs of societies is social vitality (Liu, 2022). Today, achieving environmental liveliness has become a legitimate aspiration that occupies a significant portion of the official documents in architecture and urban planning. This emphasis arises from the importance of spatial liveliness as both a goal and a means (Qiu et al., 2021). Moreover, since discussions on sustainability in architecture and urban studies have typically started from physical and structural aspects and later evolved to include social and cultural dimensions, it can be concluded that liveliness also encompasses indicators such as self-actualization, dynamism, and diversity (Turnbull et al., 2021). Therefore, it should be considered a crucial factor in creating vibrant academic spaces. In this regard, socially interactive university environments should include behavioral patterns that occur at specific time intervals. Today, open spaces in university environments are inseparable from buildings and play a fundamental role in meeting social needs. These spaces occupy a large portion of students' time on campus. Enhancing their quality can significantly promote students' self-actualization, participation, and even learning outcomes. Just as the academic buildings themselves are important, the surrounding open spaces also hold great significance. A successful open space allows social activities to grow and flourish (Afanasyev et al., 2019), where social presence, creative vitality, and intrinsic motivation serve as the theoretical foundations for spatial liveliness (Bradbury, 2019). Explaining and assessing the impact of spatial liveliness within university educational environments on the enhancement of students' self-actualization is of great importance in today's academic and research contexts. Universities are increasingly recognized as key environments for students' development and growth. Thus, creating an effective and supportive academic environment is vital for empowering students and promoting their self-actualization. Vibrant spatial realm,

as one of the influential factors in educational environments, is directly related to students' self-actualization. Feelings of comfort, safety, and effective interaction with the surrounding physical space strengthen students' confidence and communication skills. On the other hand, increased self-actualization not only improves students' academic performance but also contributes to personal empowerment and the development of essential life competencies. The importance of examining and evaluating the effects of spatial liveliness in university educational environments based on the enhancement of students' self-actualization can be approached from several perspectives. These include educational, psychological, and social aspects. In general, the significance of investigating and evaluating the effects of spatial liveliness in university educational environments based on the enhancement of students' self-actualization can be examined from various perspectives:

Educational aspect: Spatial liveliness can positively influence students' learning and academic performance. Students who study in lively and stimulating educational environments tend to show greater motivation to learn and participate in academic activities compared to those in dull or monotonous settings. Furthermore, such students often achieve higher performance in examinations and other educational tasks.

Psychological aspect: Spatial liveliness can also have a positive impact on students' mental health. Learners in vibrant educational environments generally experience greater satisfaction and well-being than those in less engaging environments. In addition, these students are less likely to suffer from stress and anxiety.

Social aspect: Vibrant spatial realm contributes to affecting positively on social relationships among students. Those who study in lively educational environments are more likely to communicate easily with others and develop stronger social connections. Overall, studying the effects of spatial liveliness in university educational environments on students' self-actual-

ization can lead to valuable outcomes across educational, psychological, and social dimensions. The findings of this research can help university administrators create dynamic and engaging learning environments that foster students' growth, development, and self-fulfillment.

MATERIALS AND METHODS

HMüller et al. (2021) examined changes in motivational regulation, satisfaction or frustration of basic psychological needs (autonomy, competence, and relatedness), and the level of mental vitality among university students before and after the mandatory shift to distance learning during the COVID-19 pandemic. The research was conducted with two samples of students from Austria and Germany: one before the transition (N = 1139) and one at the onset of remote education (N = 1835). The results showed a decrease in the satisfaction of psychological needs and an increase in their frustration. Intrinsic motivation and identified regulation declined, whereas controlled forms of motivation increased. Structural equation modeling indicated that 42% of the variance in mental vitality was explained by motivational regulation and the status of psychological needs. Moreover, motivational regulation styles served as mediators between psychological needs and mental vitality. Faizah et al. (2024) aimed to investigate the role of natural environments on university campuses in enhancing students' mental health and well-being, and to assess how academic programs leverage green spaces to address the growing psychological challenges among students. A systematic review was performed using the keywords "green areas," "well-being," and "campus" in the Scopus and LILACS databases, following PRISMA guidelines. Thirty-two relevant studies were selected. Most of the studies were conducted in the United States, Bulgaria, and China, using both objective measures of campus greenery and students' perceptions of these spaces. Mental health was evaluated using

validated psychometric instruments. The results consistently revealed a positive relationship between campus green spaces and students' well-being. The authors concluded that university campuses possess high potential for creating restorative programs and environments that help reduce students' stress and promote psychological recovery. To describe the characteristics of flourishing students, motivated by global concerns regarding academic dropout and low well-being levels. The research followed a systematic review approach involving comprehensive database searches, quality assessments of studies, and qualitative data analysis using NVivo software. The results indicated that student flourishing is influenced by psychological factors, meaning in life, social support and relationships, and environmental conditions. Flourishing students demonstrated psychological and emotional well-being, positive social functioning, a sense of achievement, and enhanced psychological performance. The findings emphasized that promoting flourishing requires a holistic approach and targeted interventions within the university setting. The authors recommended future longitudinal studies, replication in different contexts, and examination of complementary variables. Garcia et al. (2024) explored the relationships between mental health, organizational climate, and academic engagement among students at a public university in Lima. A total of 1,971 students (mean age = 21) participated. Data were collected using the Positive Mental Health Scale, the Utrecht Work Engagement Scale, and the FOCUS Organizational Climate Questionnaire. The results demonstrated strong and positive correlations between organizational climate, mental health, and academic engagement, with life satisfaction, vigor, and innovation climate emerging as key components. Mental health also had a direct effect on academic engagement. Structural equation modeling showed that organizational climate had a strong effect on mental health ($\beta = 0.64$) and engagement ($\beta = 0.49$), while mental

health had a positive effect on engagement ($\beta = 0.43$). Based on these findings, the study suggested that fostering a positive organizational climate and addressing students' psychosocial well-being are essential for enhancing academic engagement and mental health. Hartnett et al. (2021) identified the psychological characteristics associated with university students' well-being in the post-COVID-19 period and examined the relationship between the satisfaction of basic psychological needs (competence, autonomy, and relatedness), positive emotions, and intrinsic motivation for learning. The moderating role of self-regulated learning was also analyzed. Data were collected from two large samples of university students in Austria ($N = 6,071$) and Finland ($N = 1,653$). Structural equation modeling revealed that competence was the strongest predictor of positive emotions, while intrinsic motivation was predicted by both competence and autonomy. Relatedness played a significant role only among Finnish students and had a relatively weak effect on positive emotions. Self-regulated learning exerted a main effect on intrinsic motivation but showed an inconsistent moderating role. The findings provide valuable insights for developing strategies aimed at enhancing students' well-being and mitigating the negative impacts of pandemic-related educational changes. Arslan (2021) examined the mediating and moderating mechanisms underlying the relationship between loneliness and mental health among university students, particularly during the COVID-19 pandemic. The study found that mental vigor served as the primary mediator between loneliness and psychological adjustment, while the sense of belonging to the university acted as a protective moderating factor in this relationship. The research was conducted with a sample of 333 undergraduate students in Turkey. The results emphasized that increasing students' sense of belonging to their university and enhancing their mental vitality can mitigate the negative effects of loneliness and improve

their mental health. These findings hold practical implications for the design of preventive interventions within university settings. Menardo et al. (2024) conducted a validation study of the Rest@US scale, a 13-item instrument designed to measure psychological restoration in university settings across four dimensions: fascination, detachment, extent, and coherence. The scale aimed to assess how the physical university environment contributes to the enhancement of students' cognitive, physiological, and emotional resources while reducing stress and depression. The study involved 685 students from two Italian universities. Confirmatory factor analysis confirmed a strong fit for the four-factor model, indicating high reliability and criterion validity. The results showed that the dimensions of psychological restoration were negatively correlated with workload and techno-overload, and positively associated with academic performance and psycho-physical well-being. These findings demonstrate that Rest@US is a valid and reliable scale for assessing the influence of the physical university environment on students' well-being and academic performance. Makai et al. (2023) investigated the impact of the university's entrepreneurial ecosystem and support services on students' entrepreneurial intentions, focusing particularly on the transition from entrepreneurial desire to actual behavior. Using a quantitative research approach and structural equation modeling, the study surveyed students from the University of Applied Sciences in Western Transdanubia, Hungary. The findings revealed a strong correlation between students' perceptions of university support and the entrepreneurial environment. Institutional factors were found to influence perceived behavioral control, underscoring the importance of supportive academic ecosystems in fostering entrepreneurial intention and action among students. Danelidou et al. (2025) examined the influence of students' academic engagement and sense of belonging on their mental happiness and resilience. The study,

conducted among 503 students, found that those who experienced a greater sense of belonging and participated more actively in academic activities reported higher levels of happiness and resilience. The subscales of social fit and identification with the university were positively correlated with mental happiness and resilience, whereas academic engagement itself showed no significant association. These results highlight the importance of fostering supportive and participatory learning environments that strengthen students' sense of belonging and academic commitment, ultimately enhancing their psychological well-being. Danley (2022) explored the principles of sustainable architectural design in desert regions, focusing on architectural strategies, building structures, and design elements such as open spaces to enhance both indoor and outdoor comfort. To create a habitable climatic environment, inward-oriented building layouts featuring central courtyards or atriums with diverse shapes and volumes were emphasized as essential. The study highlighted the importance of moderately compact building forms with internal open spaces to reduce direct solar exposure by minimizing the external surface area relative to internal volume. Effective spatial rotation among functional zones was also found to reduce unnecessary internal circulation, improve spatial efficiency, and minimize building mass, thereby decreasing cooling demands. The use of rough-textured façades was recommended to reduce heat absorption and increase air circulation, while minimizing window surfaces—especially on western façades—was advised to prevent afternoon solar glare. Finally, the study underscored the significance of intentional urban sightline design and consideration of cityscape imagery, which contributes to the symbolic and mental perception of the surrounding environment. Eligbi (2021) emphasized the importance of supportive and stimulating environments in fostering individual creativity. The author argued that an environment should support creativity in three primary

ways: by sparking creative ideas, sustaining them, and providing opportunities for evaluation and improvement. Conversely, environments that hinder psychological or physical comfort—such as those with excessive noise, high temperature, or insufficient space—can suppress creativity. Furthermore, individual vitality stems from self-actualization and intrinsic motivation, while coercion or restriction reduces personal energy. This concept aligns with self-determination theory and the notion of vitality as a fundamental component of creative engagement. Loomis et al. (2021) found that the naturalness of environments and the perceived naturalness by individuals are related but not equivalent. From an objective perspective, all living beings are part of nature; however, many people may perceive a rose as “unnatural” because human intervention in its cultivation alters its original essence. Similarly, Du (2021) examined preferences between Far Eastern and Western landscape styles, revealing that—regardless of cultural differences—Japanese landscape types and elements such as water, vegetation, furniture, and natural path networks were the most preferred.

Methodology

This study is applied research aimed at analyzing and evaluating the impact of vitality in university educational environments on the enhancement of students' self-actualization. The research was designed based on a structural equation modeling (SEM) approach using partial least squares (PLS-SEM) within the framework of the Driver–Pressure–State–Impact–Response (DPSIR) conceptual model. Data was collected through both library-based and survey methods. In the library-based phase, relevant scholarly literature and studies on vitality and self-actualization were reviewed. In the field-based phase, data was gathered through questionnaires and interviews with higher education experts. The data collection instruments consisted of standardized questionnaires designed to measure

vitality and self-actualization indicators, whose validity and reliability were confirmed through expert review and statistical tests. The study population included faculty members, higher education specialists, and experts in designing university educational environments. The sample size was determined using purposive (judgmental) sampling to ensure sufficient theoretical saturation. For data analysis, the DPSIR conceptual model and its associated indicators were first constructed based on the collected data. Partial least squares structural equation modeling (PLS-SEM) was then applied to assess the relationships among variables, model performance, and relevant outputs. This approach allows for a direct and quantitative evaluation of the effects of vitality and its role in enhancing students' self-actualization. The study tested the following hypotheses, as illustrated in Fig.1:

H1: Driving forces have positive effects on pressures, H2: Pressures have negative effects on status, H3: Status has negative effects on effects, H4: Responses have negative effects on effects, H5: Responses have positive effects on driving forces, H6: Responses have negative effects on pressures, H7: Responses have positive effects on status. (Fig. 1)

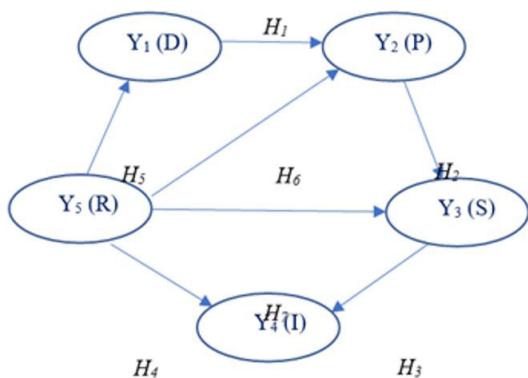


Figure 1: Illustrates the research hypotheses within the framework of the conceptual model

DISCUSSION AND FINDINGS

In this study, the fuzzy cognitive map (FCM) model was constructed using MATLAB software. MATLAB generated the FCM based on the output obtained from FCMapper software. The resulting fuzzy cognitive map is illustrated in Fig. 2.

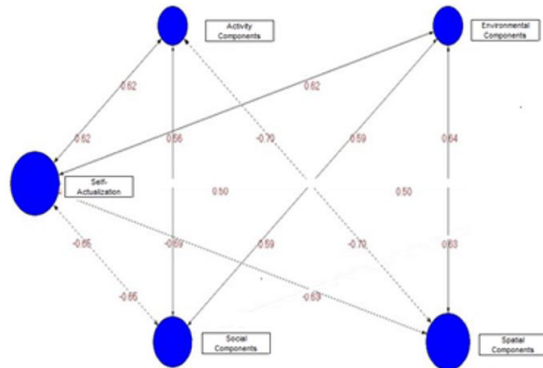


Figure 2: Fuzzy Cognitive Map Model of Engineering Factors Affecting Liveliness in University Learning Environments Based on Enhancing Students' Self-Actualization

In this model, both positive and negative causal relationships are observable. The size of the circles representing each factor indicates the centrality of that factor. Larger circles imply greater influence and susceptibility of the factor on other factors, and consequently, higher centrality. The results obtained from this model are presented in Tab.1

Scenario Formation

The final matrix, derived from the focus group opinions, was imported into the FCMapper software. In the FCM_Indices section of the software, as shown in Table 2, the influence, dependence, and centrality of each factor were determined. (Tab. 2)

According to this table, the social components, self-actualization, and activity components have the highest centrality (sum of influence and dependence), respectively. In this study, these three factors were used to examine and compare the scenarios. Three scenarios are analyzed here based on these factors.

Before the formation of scenarios, it should be noted that in the scenario construction pro-

cess, for the factor upon which the scenario is based, two values, 0 and 1, are defined. A value of 0 indicates the absence of the factor, while a

value of 1 indicates the presence of the factor without any modification. (Tab. 3)

Table 1: Results of the FCM Model

Factor	Rank	Influence	Dependence	Centrality
Social Components	1	3.07	2.46	5.53
Activity Components	2	2.43	2.43	4.87
Self-Actualization	3	2/03	2.77	4.80
Spatial Components	4	1/85	1.85	3.69
Environmental Components	5	1/26	1.88	3.15

Table 2: Centrality Matrix of Factors

Factors	Influencing Power	Influenced Power	Centrality
Social Components	3.07	3.07	6.15
Environmental Components	1.88	1.88	3.77
Spatial Components	1.85	1.85	3.69
Self-actualization	2.77	2.77	5.53
Activity-related Components	2.43	2.43	4.87

Table 3: Scenario Formation Matrix (Scenario 1)

Factors	Stage 1	Stage 2	Results of Stage 1	Results of Stage 2	Code
Social Components	1	0	0.59	0	0
Environmental Components	1	-	0.59	0.6	2
Spatial Components	1	-	0.75	0.61	6
Self-actualization	1	-	0.55	0	6
Activity-related Components	1	-	0.7	0.74	2

The results of Scenario 1 in FCMapper indicate that if the social components are eliminated, the environmental and activity components increase significantly, while the spatial components and self-actualization decrease significantly.

Scenario 2: In this scenario, the activity components are set to zero in order to assess the resulting changes in the other factors, which can be observed in the second stage. The implementation of this scenario and its outcomes are presented in Tab.4.

The results of Scenario 2 indicate that if the activity components are set to zero, the environmental components, spatial components,

and self-actualization change significantly in a negative direction, while the social components change substantially in a positive direction.

Scenario 3: In the third scenario, the social components remain unchanged (value = 1), while the activity components are set to zero. The aim is to examine the variations in the remaining factors. The results obtained from this scenario are presented in Tab.5.

The results of Scenario 2 indicate that if the activity components are set to zero, the environmental components, spatial components, and self-actualization change significantly in a negative direction, while the social components change substantially in a positive direction.

Table 4: Scenario 2 Formation Matrix

Factors	Phase 1	Phase 2	Results of Phase 1	Results of Phase 2	Code
Social Components	1	-	0.59	0.67	2
Environmental Components	1	-	0.59	0.51	6
Spatial Components	1	-	0.75	0.68	6
Self-actualization	1	-	0.55	0.52	6
Activity-related Components	1	0	0.70	0	0

Scenario 3: In the third scenario, the social components remain unchanged (value = 1), while the activity components are set to zero.

The aim is to examine the variations in the remaining factors. The results obtained from this scenario are presented in Tab.5.

Table 5: Scenario 3 Formation Matrix

Factors	Phase 1	Phase 2	Results of Phase 1	Results of Phase 2	Code
Social Components	1	1	0.59	1.00	1
Environmental Components	1	-	0.59	0.57	6
Spatial Components	1	-	0.75	0.71	6
Self-actualization	1	-	0.55	0.47	6
Activity-related Components	1	0	0.70	0.00	0

The results of this scenario indicate that when the social components remain constant (value = 1) and the activity components are set to zero, other factors in the model representing the effects of vitality in academic environments based on the enhancement of students' self-actualization experience significant negative changes. The influence of the components on the factors contributing to vitality in university educational environments based on the enhancement of students' self-actualization was analyzed. After defining the research methodology and collecting the required data using appropriate instruments, the researcher proceeds to classify, code, and analyze the data using suitable statistical techniques consistent with the research design and variable types. Linking the research topic to a body of existing information requires creative thinking. Often, identifying data sources relevant to the research question demands mental ingenuity. Likewise, the organization and arrangement of data require creativity. The data analysis process is a multi-step procedure in

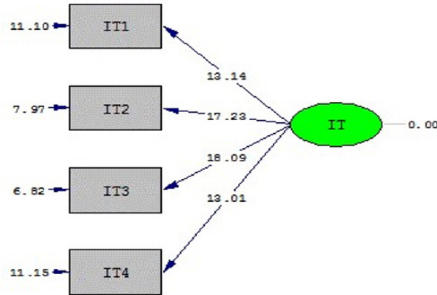
which data collected from the statistical population (sample) through data collection tools is summarized, coded, categorized, and ultimately processed to enable different analyses and relationships among variables for hypothesis testing. In this section, to analyze the collected data, the measurement model is first evaluated to answer the first three research questions. Then, for testing the structural model and hypotheses and addressing the fourth and fifth questions, the path coefficients and t-statistics are used. Data analysis is conducted using SmartPLS statistical software.

Measurement and Structural Model Fit

To estimate the measurement model, it is recommended to focus on Confirmatory Factor Analysis (CFA), which is a key part of the measurement framework. This model discusses how latent variables are measured through observed variables and evaluates the adequacy of the measurement indicators in representing their underlying constructs.

Self-Actualization Characteristics Variable

Research Question 1: What are the main components explaining the characteristics of self-actualization among the factors influencing and resulting from vitality in university educational environments based on the enhancement of students' self-actualization?



Chi-Square=5.92, df=2, P-value=0.02148, RMSEA=0.087

Figure 3: Overall Measurement Model and Explanation of Social Components Approaches (Standardized Mode)

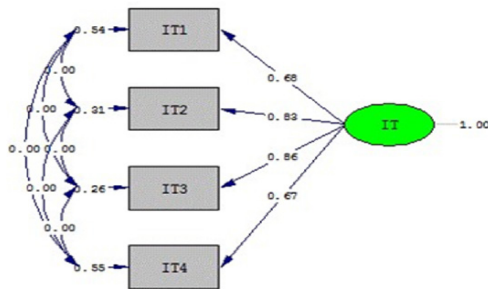
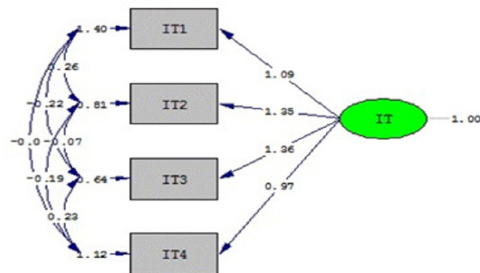


Figure 4: Overall Measurement Model and Identification of Self-Actualization Characteristics Components (Significance Mode)



Chi-Square=5.92, df=2, P-value=0.02148, RMSEA=0.087

Figure 5: Overall Measurement Model and Identification of Self-Actualization Characteristics Components (Estimated Mode)

Structural Equation Modeling (Model Fit Analysis)

In the present study, the correlations between variables were examined using SmartPLS software. To investigate the causal relationships between independent and dependent variables and to validate the overall model, path analysis was employed. The path analysis was conducted through the SmartPLS software. The results obtained from the SmartPLS outputs indicate that the chi-square to degrees of freedom ratio is less than three, confirming an acceptable model fit. Furthermore, other goodness-of-fit indices also support the adequacy of the structural model. It is worth noting that to confirm or reject the research hypotheses, standardized coefficients and significance values (t-values) were used. For all paths, a confidence level of 95% and an error level of 5% were considered. (Tab. 7)

The statistical analysis, as shown in Table 7, indicates that the t-values for the paths between the latent variable of self-actualization characteristics and the observed variables—namely integration, flexibility, alignment, and management—are greater than 1.96. Therefore, these relationships are confirmed as statistically significant. Moreover, since the obtained t-values are positive, the effects are direct. Accordingly, the variables integration, flexibility, alignment, and management act as determinants of self-actualization characteristics within the factors influencing and resulting from vitality in academic environments based on the enhancement of students' self-actualization.

Social Components Variable

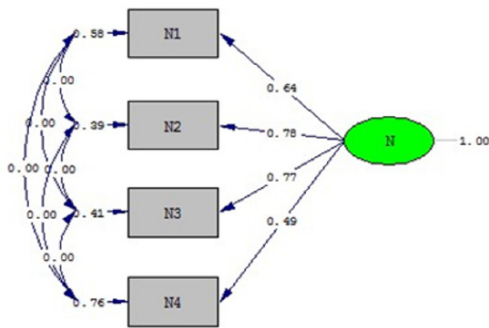
Research Question 2: What are the main components explaining the approaches of social components among the factors influencing and resulting from vitality in university educational environments based on the enhancement of students' self-actualization?

Table 6: Goodness-of-Fit Indices of the Structural Equation Model for Self-Actualization Characteristics

Model Evaluation	Value	Acceptable Threshold	Full Name	Index
Model Confirmed	5.92	-	Chi-Square	(χ^2)
Model Confirmed	2.96	$\chi^2/df < 3$	Chi-Square Divided by Degrees of Freedom	χ^2
Model Confirmed	0.087	RMSEA $\leq 1/0$	Root Mean Square Error of Approximation	RMSEA
Model Confirmed	0.99	NFI $> 9/0$	Normed Fit Index	NFI
Model Confirmed	0.99	GFI $> 9/0$	Goodness of Fit Index	GFI
Model Confirmed	0.99	CFI $> 9/0$	99/0 Comparative Fit Index	CFI
Model Confirmed	0.99	IFI $> 9/0$	Incremental Fit Index	IFI

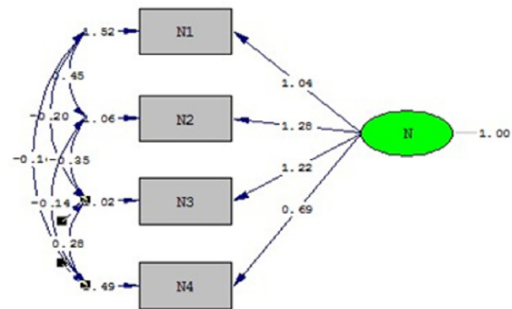
Table 7: summarizes the significance coefficients and the results of the proposed hypotheses.

Result	t-Value	Standardized Coefficient (β)	Path Relationship
Supported	13/14	0/68	Self-Actualization Characteristics \rightarrow Integration
Supported	17/23	0/83	Self-Actualization Characteristics \rightarrow Flexibility
Supported	18/09	0/86	Self-Actualization Characteristics \rightarrow Alignment
Supported	13/01	0/67	Self-Actualization Characteristics \rightarrow Management



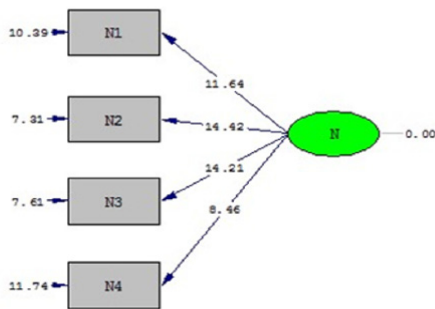
Chi-Square=5.64, df=2, P-value=0.02188, RMSEA=0.093

Figure 6: Overall Measurement Model and Explanation of Social Components Approaches (Standardized Mode)



Chi-Square=5.64, df=2, P-value=0.02188, RMSEA=0.093

Figure 8: Overall Measurement Model and Explanation of Social Components Approaches (Estimated Mode)



Chi-Square=5.64, df=2, P-value=0.02188, RMSEA=0.093

Figure 7: Overall Measurement Model and Explanation of Social Components Approaches (Significance Mode)

The statistical analysis, based on Table 9, indicates that the t-values for the paths between the latent variable Social Component Approaches and the observed variables Cost Flexibility, Implementation Flexibility, Adaptability, and Recovery (Improvement) are all greater than 1.96. Therefore, these relationships are confirmed. Furthermore, since the obtained t-values are positive, these effects are considered direct. Accordingly, the variables Cost Flexibility, Implementation Flexibility, Adaptability, and Recovery (Improvement) explain the latent construct

Social Component Approaches within the factors influencing vitality in academic environments based on the enhancement of students' self-actualization.

Activity Components in Factors Influencing Vitality in Academic Environments Based on the En-

hancement of Students' Self-Actualization

Research Question 3: What are the main components explaining the Activity Factors influencing vitality in academic environments based on the enhancement of students' self-actualization?

Table 8: Goodness-of-Fit Indices for the Structural Equation Model of Social Component Approaches

Model Status	Observed Value	Acceptable Value	Full Name	Index
Model confirmed	5.64	-	Chi-Square Statistics	χ^2 (Chi-Square)
Model confirmed	2.82	$\chi^2/df < 3$	Chi-Square Divided by Degrees of Freedom	χ^2/df
Model confirmed	0.093	RMSEA $\leq 1/0$	Root Mean Square Error of Approximation	RMSEA
Model confirmed	0.98	NFI $> 9/0$	Normed Fit Index	NFI
Model confirmed	0.99	GFI $> 9/0$	Goodness of Fit Index	GFI
Model confirmed	0.99	CFI $> 9/0$	Comparative Fit Index	CFI
Model confirmed	0.99	IFI $> 9/0$	Incremental Fit Index	IFI

Table 9: Results of the Structural Equation Modeling (SEM) for the Research Model of Social Component Approaches

Result	t-value (Significance)	Standard Coefficient	Path
Confirmed	11/64	0/64	Social Component Approaches → Cost Flexibility
Confirmed	14/42	0/78	Social Component Approaches → Implementation Flexibility
Confirmed	14/21	0/77	Social Component Approaches → Adaptability
Confirmed	8/46	0/49	Social Component Approaches → Recovery (Improvement)

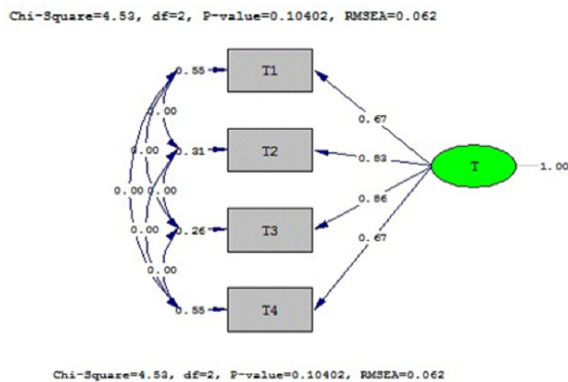


Figure 9: Measurement model and identification of the explaining components of the Activity Factors (Standardized Model)

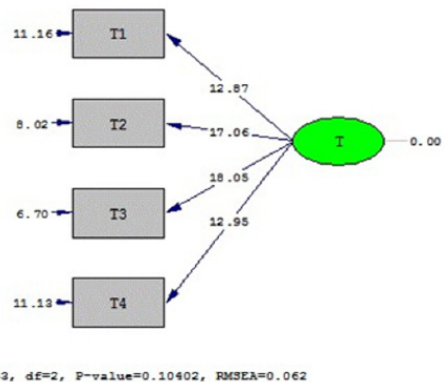


Figure 10: Measurement model and identification of the explaining components of the Activity Factors (Significance Model)

Structural Equation Modeling Analysis
(Model Fit Assessment)

Table 10: Goodness-of-Fit Indices for the Structural Equation Model Explaining the Activity Factors

Model Status	Observed Value	Acceptable Value	Full Name	Index
Model confirmed	4.53	-	ChiSquare Divided	χ^2 (Chi-Square)
Model confirmed	2.26	$\chi^2/df < 3$	ChiSquare Divided to Degrees of Freedom	χ^2/df
Model confirmed	0.062	RMSEA \leq 1/0	Root Mean Square Error of Approximation	RMSEA
Model confirmed	0.99	NFI $>$ 9/0	Normed Fit Index	NFI
Model confirmed	0.99	GFI $>$ 9/0	Goodness of Fit Index	GFI
Model confirmed	1.00	CFI $>$ 9/0	Comparative Fit Index	CFI
Model confirmed	1.00	IFI $>$ 9/0	Incremental Fit Index	IFI

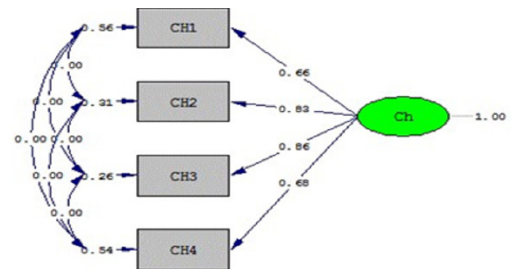
Table 11: Results of the Structural Equation Model Explaining the Activity Factors

Result	t-value (Significance)	Standardized Coefficient	Path / Relationship
Supported	12/87	0/67	Activity Factors → Planning
Supported	17/06	0/83	Activity Factors → Continuous Improvement
Supported	18/05	0/86	Activity Factors → Mutual Interaction
Supported	12/95	0/67	Activity Factors → Human Resources

According to Table 11, the t-values for the paths between the latent variable Activity Factors and the observed variables – Planning, Continuous Improvement, Mutual Interaction, and Human Resources – are all greater than 1.96, indicating that these relationships are statistically significant. Moreover, since all t-values are positive, the effects are direct and positive. Therefore, the variables Planning, Continuous Improvement, Mutual Interaction, and Human Resources are considered the main explanatory factors of the Activity Factors influencing vitality in academic environments based on the enhancement of students’ self-actualization

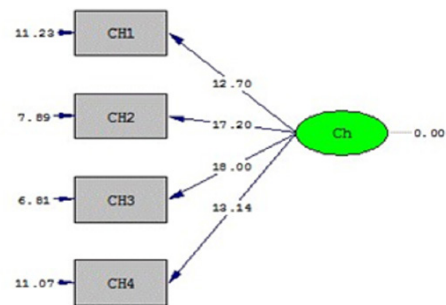
Spatial Components of the Factors Influencing Vitality in Academic Environments Based on the Enhancement of Students’ Self-Actualization

What are the main components explaining the Spatial Factors influencing vitality in academic environments based on the enhancement of students’ self-actualization?



Chi-Square=3.58, df=2, P-value=0.16658, RMSEA=0.049

Figure 12: Measurement model and identification of the Spatial Components (Standardized Model)



Chi-Square=3.58, df=2, P-value=0.16658, RMSEA=0.049

Figure 13: Measurement model and identification of the Spatial Components (Significance Model)

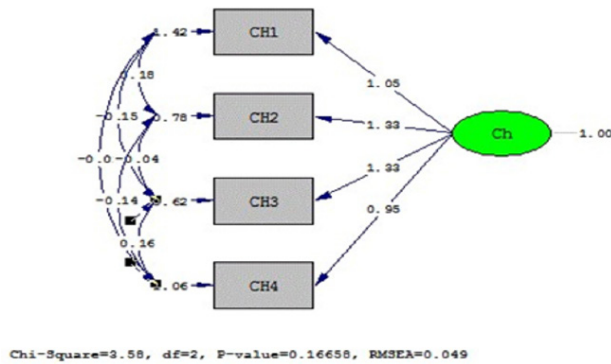


Figure 14: Measurement model and identification of the Spatial Components (Estimated Model)

Table 12: Goodness-of-Fit Indices for the Structural Equation Model of the Spatial Components

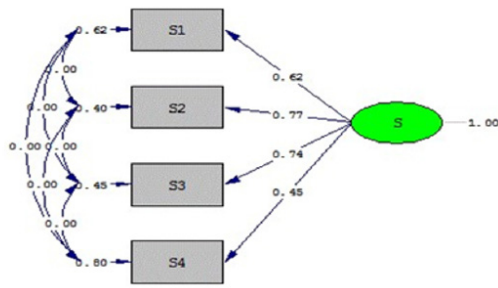
Model Status	Observed Value	Acceptable Value	Full Name	Index
Model confirmed	3.58	-	ChiSquare Divided	χ^2
Model confirmed	1.79	$\chi^2/df < 3$	ChiSquare Divided to Degrees of Freedom	χ^2/df
Model confirmed	0.049	RMSEA $\leq 1/0$	Root Mean Square Error of Approximation	RMSEA
Model confirmed	0.99	NFI $> 9/0$	Normed Fit Index	NFI
Model confirmed	0.99	GFI $> 9/0$	Goodness of Fit Index	GFI
Model confirmed	1.00	CFI $> 9/0$	Comparative Fit Index	CFI
Model confirmed	1.00	IFI $> 9/0$	Incremental Fit Index	IFI

Table 13: Structural Equation Modeling Results for the Spatial Components

Result	t-value	Standardized Coefficient	Path
Supported	12/70	0/66	Spatial Components → Extent
Supported	17/20	0/83	Spatial Components → Continuous Improvement
Supported	18/00	0/86	Spatial Components → Mutual Interaction
Supported	13/14	0/67	Spatial Components → Human Resources

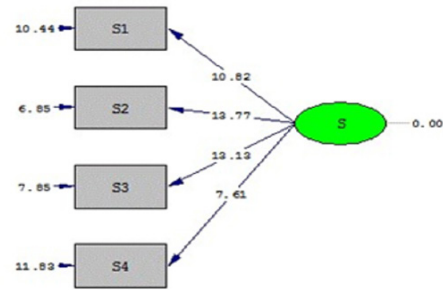
Interpretation of Results (Table 13) According to Table 13, the t-values for the relationships between the latent variable Spatial Components and the observed variables – Extent, Planning, Process Integration, and Shared Values – are all greater than 1.96, indicating that these relationships are statistically significant. Moreover, since all t-values are positive, these effects are direct and positive. Therefore, the variables Extent, Planning, Process Integration, and Shared Values can be identified as the main explanatory factors of the Spatial Components in the

framework of factors influencing and reflecting vitality in university educational environments based on the enhancement of students' self-actualization. Environmental Components in the Model of Factors Influencing and Reflecting Vitality in University Educational Environments Based on the Enhancement of Students' Self-Actualization What are the main components that explain the environmental factors influencing and reflecting vitality in university educational environments based on the enhancement of students' self-actualization?



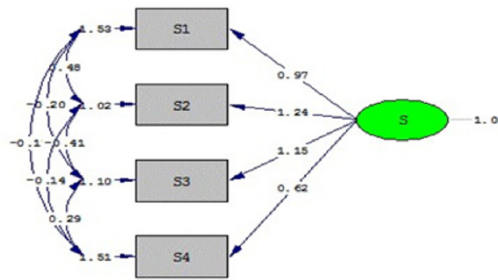
Chi-Square=5.16, df=2, P-value=0.01688, RMSEA=0.097

Figure 15: Measurement Model and Determination of Environmental Components in the Standard State



Chi-Square=5.16, df=2, P-value=0.01688, RMSEA=0.097

Figure 16: Measurement Model and Determination of Environmental Components in the Significance State



Chi-Square=5.16, df=2, P-value=0.01688, RMSEA=0.097

Figure 17: Measurement Model and Determination of Environmental Components in the Estimated State

Table 14: Goodness-of-Fit Indices for the Structural Equation Model of Environmental Components

Model Status	Observed Value	Acceptable Value	Full Name	Index
Model confirmed	5.16	-	ChiSquare Divided	χ^2
Model confirmed	2.58	$\chi^2/df < 3$	ChiSquare Divided to Degrees of Freedom	χ^2/df
Model confirmed	0.097	RMSEA $\leq 1/0$	Root Mean Square Error of Approximation	RMSEA
Model confirmed	0.98	NFI $> 9/0$	Normed Fit Index	NFI
Model confirmed	0.99	GFI $> 9/0$	Goodness of Fit Index	GFI
Model confirmed	0.98	CFI $> 9/0$	Comparative Fit Index	CFI
Model confirmed	0.98	IFI $> 9/0$	Incremental Fit Index	IFI

Table 15: Results of the Structural Equation Model for Environmental Components

Result	Significance (t-value)	Standard Coefficient	Path Relationship / Effect
Confirmed	10/82	0/62	Environmental Components → Decision-Making Method
Confirmed	13/77	0/77	Environmental Components → Decision-Making Style
Confirmed	13/13	0/74	Environmental Components → Intra-Institutional Relationships
Confirmed	7/61	0/45	Environmental Components → Legal Arrangements

According to Table 15, the significance values for the paths between the latent variable of environmental components and the observed variables – decision-making method, decision-making style, intra-institutional relationships, and legal arrangements – are greater than 1.96. Therefore, these relationships are confirmed. Since the obtained significance values are positive, the effects are direct. Accordingly, the variables of decision-making method, decision-making style, intra-institutional relationships, and legal arrangements are the main explanatory indicators of the environmental components variable in the model of factors influencing vitality in university educational environments based on the enhancement of students' self-actualization.

RESULT AND CONCLUSION

The fuzzy cognitive map (FCM) related to the factors influencing vitality in university educational environments based on the enhancement of students' self-actualization was designed and analyzed in this study to identify and thoroughly examine the complex interrelationships among the influencing variables. This part of the research was conducted in three main stages.

In the first stage, by employing the Fuzzy Cognitive Mapping (FCM) technique, the initial matrix representing the relationships among the influencing factors was developed. This technique allows the integration of expert opinions with varying degrees of fuzzy confidence, thereby producing the final success matrix, which demonstrates both the strength and direction of the causal influences among variables. This matrix plays a key role in understanding the structural framework of the vitality system within the educational environment. In the second stage, the final success matrix was entered into the specialized software FCMapper to analyze the results related to the structure and interactions of the factors using its analytical capabilities. In

this stage, three different scenarios were identified and evaluated based on the input data, each representing different conditions of the effects of vitality on students' self-actualization. This scenario analysis greatly contributed to a better understanding of the system's sensitivities and critical points. In the final stage, using MATLAB software, the fuzzy cognitive map diagram was drawn, providing a clear visual representation of the network of relationships among the influencing factors. This graphical illustration shows the interactions between various factors, the intensity of influences, and the causal paths in an understandable and tangible manner, enabling both qualitative and quantitative analysis of the model.

The results obtained from using the FCMapper software in the scenario analysis section indicate that:

In the first scenario, if the index of social components becomes zero, the indices of environmental and activity components change significantly in a positive direction, while the spatial and self-actualization indices change considerably in a negative direction. In fact, the results of this scenario indicate that the lack of control over the effects of vitality in university educational environments based on enhancing students' self-actualization leads to excessive reporting of new problems and challenges for adapting to complex and emerging issues. On the other hand, it results in a significant decrease in the spatial component index and, ultimately, reduces the desired level of self-actualization.

In the second scenario, when the index of activity components becomes zero, the index of social components changes significantly in a positive direction, while other factors change considerably in a negative direction. The results of this scenario show that the lack of adaptability and the null value of activity components lead to an excessive reduction in the indices of environmental, spatial, and self-actualization components, which negatively affects the proper pattern of vitality impacts in university educa-

tional environments based on the enhancement of students' self-actualization.

In the third scenario, the flexibility index becomes zero while the social components index is set to one. The results of this scenario indicate that when the activity component index is zero and the social component index remains constant, other factors of the proper model of vitality effects in university educational environments based on enhancing students' self-actualization change significantly in a negative direction. Considering the results obtained from these three scenarios, the importance and the strong influence and sensitivity of the social components factor compared to other factors in the optimal model of vitality effects in university educational environments based on enhancing students' self-actualization are evident.

In the final stage (Step 3) of this study, the fuzzy cognitive map was drawn using MATLAB software, as shown in Figure 1. In this map, the size of each circle represents the degree of centrality of that factor relative to others, such that the larger the circle, the greater its influence and dependency within the system. In this research, the circle corresponding to the social components index is the largest, indicating that the centrality of the social components index—compared to other factors—is higher in the model of vitality effects in university educational environments based on enhancing students' self-actualization, and therefore it holds greater significance.

According to the fuzzy cognitive map, the social components index in this area has a bilateral and positive relationship with the environmental components and spatial components, with respective weights of 0.62, 0.62, and 0.50. This factor also has a bilateral and negative relationship (**weight = 0.65**) with the activity components index, and a unilateral and negative relationship (**weight = 0.69**) with the self-actualization index. The results of the third step indicate that the social components factor possesses a high degree of centrality in the resili-

ence of the optimal model of vitality effects in university educational environments based on the enhancement of students' self-actualization. This means that this factor not only has a strong influence on other factors, but is also highly influenced by them.

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HOW TO CITE THIS ARTICLE

Zolfaghari, F., Kameli, M. and Kalantari, M. (2025). A Study on Fuzzy Cognitive Mapping to Analyze Factors that Impact the Model of Vitality Effects in University Educational Environments with a Focus on Promoting Students' Self-Actualization. (*e732302*). *International Journal of Urban Management and Energy Sustainability*, (), e732302 doi: 10.22034/ijumes.2025.2077266.1343 DOI: [10.22034/ijumes.2025.2077266.1343](https://doi.org/10.22034/ijumes.2025.2077266.1343)

