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Article

Factors of economic development in the periphery of the Isthmus of Tehuantepec Interoceanic Corridor

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Abstract: The endogenous, human, and social factors influencing the economic development of the municipalities of San Juan Cotzocón and San Pedro y San Pablo Ayutla in the Istmo de Tehuantepec region of the state of Oaxaca are analyzed. The hypothesis posits that the dimensions of endogenous development, social capital, and human capital directly impact the economic development of the respective municipalities. The study involved administering 262 questionnaires to the residents of these municipalities during the month of May 2023. The collected data were examined using exploratory factor analysis to determine the underlying structure and structural equation modeling to estimate the effects and relationships between variables. Results indicate that endogenous development, social capital, and human capital are factors in the economic development of the studied communities, with endogenous development being the most influential factor due to its statistical significance. Notably, the existence of tourist and cultural attractions in the municipalities emerges as a catalyst for local economic development in response to the establishment and operation of the Isthmus of Tehuantepec Interoceanic Corridor.

Keywords: social capital; human capital; endogenous development; local development

1. Introduction

The isthmuses of Panama, Corinth, and Suez are examples of how humans utilize geographical features to facilitate the connection of two areas through a narrow strip of land bordered by sea on both sides, in order to promote global trade. In Mexico, the Isthmus of Tehuantepec, located in the southeast of the country across the territories of the states of Veracruz and Oaxaca, comprises a strip of just 200 km in a straight line between the Pacific and Atlantic Oceans.

Before the arrival of the Spanish to the American continent, the Isthmus of Tehuantepec was a coveted transit route for the Mexicas, Zapotecs, and Mayans. With Hernán Cortés' arrival to these lands in the 16th century, the creation of an interoceanic route to reach India was proposed to the king of Spain. During the 19th century, colonial powers sought control of the Isthmus of Tehuantepec, with the notable intention of the Americans to build a canal in this province to turn the Gulf of Mexico into an American lake. After overcoming imperialistic attempts, it was President Porfirio Díaz who managed to connect the ports of Coatzacoalcos in the Atlantic and Salina Cruz in the Pacific, with the inauguration of the Southeast Railroad in 1894 (Gómez, 2005).

Currently, the Government of the Republic aims to consolidate the Isthmus of Tehuantepec as a strategic geographical center globally, with the implementation of the Isthmus of Tehuantepec Interoceanic Corridor (CIIT) project. The CIIT was

created by presidential decree in 2019 (DOF, 2019). According to the official document titled Institutional Program of the Isthmus of Tehuantepec Interoceanic Corridor 2023–2024 (DOF, 2023), the CIIT's primary objective is to contribute to the development of the region with a comprehensive, sustainable, and inclusive vision that promotes economic, productive, and cultural growth, as well as the establishment of development poles for well-being.

The program encompasses a total of 79 municipalities: 46 municipalities in Oaxaca and 33 municipalities in Veracruz. The municipalities were chosen for their proximity to the Isthmus of Tehuantepec Railway, cultural relevance, historical productive relationships, logistical significance, and productive potential to make the region competitive (DOF, 2023).

The program highlights Veracruz's contribution to the national wealth, constituting 4.5% of the GDP in 2021, in contrast to Oaxaca's modest 1.5% participation. Disparities are also evident in the composition of the economically active population (EAP) in the Isthmus of Tehuantepec region. Veracruz municipalities in this region account for 70.8% of the EAP, with Coatzacoalcos alone representing 58.4% of the economic units in the region. Regionally, the occupied population is primarily engaged in the services sector, followed by commerce, and agriculture ranks last (DOF, 2023).

The main strategies of the CIIT institutional program include (DOF, 2023):

- Establishment of Development Hubs by securing lands and identifying productive vocations in each hub.
- Promotion of the agri-food and agro-industrial sectors through studies identifying regional production chains, their connection to the market, and the encouragement of innovation, collaboration, and public-private investment.
- Promotion of industrial development through studies for tax incentives and support programs, encouragement of participatory programs and schemes, and the promotion of productive chains in the social sector of the economy and micro, small, and medium-sized enterprises.
- Encouragement of both domestic and foreign investment in Development Hubs and the region.
- Coordination of diagnosis, studies, and projects for the implementation of the Isthmus Logistics Platform through a competitive and efficient transportation, energy, telecommunications, and connectivity system with the international market for regional development.

Specifically, the municipalities within the CIIT belonging to the state of Oaxaca are predominantly grouped in what is considered the Isthmus of Tehuantepec region, comprising the administrative districts of Juchitán and Tehuantepec. Due to its geographical extent, this region is the largest in the state and is the best connected. It also presents the best basic indicators of social development and poverty in the region. Additionally, the region boasts the highest levels of income and production in the state. In contrast, neighboring regions such as the Sierra Norte and Sierra Sur show high levels of marginalization and poverty.

The CIIT polygon established a boundary between the municipalities directly benefiting from the program and those that were physically and budgetarily excluded

from the project, such as the 19 municipalities of the Mixe District in the Sierra Norte. The Mixes are an indigenous group that historically occupied a strip of the Isthmus of Tehuantepec and currently maintains economic and social relations with Zapotecs and Chinantecs in the northern area, Zapotecs of the Valley in the south, and Zapotecs of the Isthmus in the southeast (INPI, 2017). The Mixes are a population with high levels of social lag and are one of the main sources of migrants in the state.

In this context, the present research aims to analyze the influence of endogenous, social, and human factors contributing to local economic development in relation to the installation and operation of the CIIT in the municipalities of San Juan Cotzocón and San Pedro y San Pablo Ayutla located in the lower area of the Mixe District of the Sierra Norte of the state of Oaxaca.

The study results will contribute to the development of methodologies that allow for the relationship between the concepts of endogenous development, social capital, and human capital. Generally, current research based on empirical evidence addresses these topics separately or, in some cases, places social or human capital as drivers of local development. However, all three elements together provide a clear explanation of the characteristics and potentials of territories to promote their development. By utilizing the structural equation modeling, applied to process and analyze information, the study was able to verify the relationship between local development and the constructs proposed in the study.

The study also aims to contribute to the definition of public policies, specifically seeking to draw the attention of government authorities so that the CIIT does not become an economic enclave that isolates other areas or regions of the country from development.

The document begins with a theoretical review of concepts such as local development, endogenous development, social capital, and human capital, serving as a framework for explaining the studied phenomenon and formulating the research hypothesis. The methodology, describing the sample size, information collection technique, and statistical methods used for data analysis, is presented next. A brief mention of the demographic, economic, and social characteristics of the municipalities of San Juan Cotzocón and San Pedro y San Pablo Ayutla follows. The results of the exploratory factor analysis and structural equation model are then presented, and finally, conclusions are drawn.

Literature review

Economic growth and equity are concepts present in development economists' work (Lustig, 1995). The concern is focused on achieving a positive rate of income redistribution and satisfying the basic needs of the population (Cárdenas and Michel, 2018; Reyes, 2002). Sen (2000) criticizes the conception of development based on per capita production growth, instead advocating for placing the means and ends of development in the expansion of individual's fundamental freedoms. According to classical economists, economic growth depended on the combination of two production factors: capital and labor, with their accumulation and increase boosting economic growth; Schumpeter (1949) added that innovation and sociocultural factors generated economic development.

More recent studies on this topic consider determinants of economic growth to include the growth rate of the workforce, the proportion of national income saved and invested, and the rate of technological improvements. Cárdenas and Michel (2018) list a tentative set of factors, both exogenous and endogenous, as determinants of economic development, including land, capital, labor, natural resources, population, technology, innovation, savings, investment, international trade and investments, human capital, and social capital.

Approaches to development economics are based on both country-level and local-level perspectives. From the perspective of the country as the object of study, the analysis does not incorporate the dimension of space, assuming that economic development within countries behaves homogeneously. However, reality shows that the characteristics and levels of development in geographic areas within countries are often noticeably unequal (Tello, 2006).

So, it begs the question: What explains why some geographic areas or regions produce more wealth than others? And what determines regional development? The answer can be found in the theories of space or geography; theories of uneven development that study the causes of differences in the pace and level of development between regions; as well as the theory of development and growth economics (Cárdenas and Michel, 2018).

One of the most recent theories linking development and territory is the theory of endogenous development, which arises from the convergence of two lines of research: one that seeks to identify factors to generate development in lagging localities and territories, and another that emerges after analyzing the economic growth of regions in southern Europe (Vásquez, 2007). The endogenous development approach is a new territorial approach to development, so the growth and accumulation processes of a territory are related to the culture and institutions specific to the inhabitants of those spaces, which are the source of decisions and patterns of savings and investment (Manet, 2014).

The theory of endogenous development conditions production growth on the social and institutional organization of the territory; it proposes a more complex approach to the capital accumulation process, which leads to rethinking economic development policies from the territory and gives civil society a leading role in defining the future of the economy (Vásquez, 2007).

For Vásquez (2007), endogenous development as a process can be visualized from two different perspectives: the populist and the evolutionary. The populist approach is an optimistic interpretation of development, considering it as an autonomous process supported by local resources and capable of occurring in any territory because all territories have a development potential. Therefore, it is up to residents and social organizations to shape the process through local initiatives. In this context, it is the responsibility of governments to design and manage policies from the bottom up, in a democratic development environment.

The proposed models of this approach include: autonomous territorial development, solidarity initiatives such as social economy, and participatory democracy. The deficiencies of this perspective lie in: separating development from different forms of capital accumulation; ignoring savings and investment as mechanisms for sustainable development; underestimating the importance of

innovation and productive organization for achieving increasing returns, and; disregarding the integration of the local economy into the global economic system, which ultimately affects its dynamics and conditions its growth (Vásquez, 2007).

From the evolutionary approach, efforts aim to identify the mechanisms that promote growth and structural change. These endogenous factors include flexible production organization, technological change and innovation diffusion, territorial and urban dynamics, and flexibility and transformation of institutions (Vázquez, 2002). The weaknesses of this perspective are associated with a partial view of the economic system that does not recognize the relevance of macroeconomic functioning and the formation of the international economy (Vásquez, 2007).

Despite the limitations of the populist and evolutionary approaches, the theory of endogenous development facilitates the formulation of strategies and public policies regarding the entrepreneurial capacity of economic agents, the creativity of the population, and the resilience of local actors to the pressures of globalization, as factors for transforming the economies of territories.

Thus, there is a clear relationship between economic development, endogenous development, social capital, and human capital. For example, Olivares et al. (2008) consider endogenous development as a tool to strengthen social capital; Camagni (2004), Sassone and Camacho (2005), and Luyando et al. (2016) specify that thanks to the presence of social capital, competitive advantages are obtained in local economies; Bourdieu (2000), Banda and Peñaflor (2003), and Solís and Limas (2013) attribute to various forms of capital, including human and social capital, the ability to stimulate economic development. Regardless of the scale and causal relationships between endogenous development, social capital, and human capital, the high value of these categories of analysis for explaining the economic development of territories cannot be disputed. Therefore, the theoretical references on social capital and human capital are presented below.

In economic science, capital was originally conceived as assets produced by individuals, including physical and financial capital. Later, the concept expanded to include inherited assets, such as natural resources, and those resulting from investment in people to improve their productivity, known as human capital. Finally, the term also encompasses other forms related to social interaction, termed as social capital. The basic characteristic of all these forms of capital is that they represent stocks of assets that contribute to resource flows. These flows are perceived as streams of benefits or incomes, acknowledging that they are ongoing processes and not singular relationships. A portion of the value created with the use of capital can be utilized to increase or at least preserve the stock of capital. All these stocks are inherited from one generation to the next and can accumulate, be maintained, or reduced depending on how they are used (Uphoff, 2000).

At present, there is no exact definition of what is considered social capital; the concept has evolved over time and has acquired a multidisciplinary character, being used to try to understand different issues such as social tensions, conflicts, local development, and rural development (Giacovelli, 2022). The concept was originally introduced by Coleman (1988), who justified it as a complement to interpretations of holism and methodological individualism. It is conceived as a resource that favors productive activity and is produced through social interaction. It is less tangible than

physical and human capital because it is embedded within social structures. For example, a group of people characterized by trust and solidarity will achieve better results than another group lacking these common values.

Baker (1990) limits the scope of social capital solely to the structure of social relationship networks, while Bourdieu (1993) and Putnam (1995) incorporate access to real or potential resources of a group or community through these networks into the term. Following Nahapiet and Ghoshal (1998), social capital can be summarized as the networks of relationships and the assets that can be mobilized through them.

For social capital to be present, the individual must be part of a social group or be a member of a network of social relationships. Material benefits derive from membership in some kind of group, for example, favors received from beneficial relationships with economically powerful groups or actors, as well as privileges resulting from membership in a select or famous group. The network of relationships is the result of individual or collective investment strategies, whether conscious or unconscious, aimed at forming and maintaining social relationships that promise immediate or future benefits (Bourdieu, 2000).

Coleman (1988) (as cited in the study of Ramírez (2005)) defines social capital as the benefits that individuals extract from the group to which they belong. This implies that the volume of available social capital depends not only on the network of connections but also on the amount of economic and symbolic capital possessed by the group to which one belongs. Hence, there is an unequal distribution and extraction of social capital among social groups or networks. To define the boundaries of the concept, Putnam (1993) points out that social capital is discerned as a collective advantage, it is a public good and not private property, typically consisting of transferable links and norms from one social environment to another. Therefore, it can be an appropriate approach for formulating new strategies for territorial development.

To clarify the dimensions of social capital from a theoretical perspective, Nahapiet and Ghoshal (1998) and Broska (2021) distinguish three clusters within the concept: structural, relational, and cognitive. Although the same authors acknowledge that the three groups are deeply interconnected. The structural dimension refers to the general pattern of connections between actors, identifying three facets: the existence or absence of relationships between actors, the configuration of the network, and the creation of a network that can be used for interests other than the original ones. Relational integration describes the type of relationships that people have built based on a history of interactions. Finally, the cognitive dimension refers to the interpretations and shared meanings among members of a group (Nahapiet and Ghoshal, 1998).

The measurement of the different dimensions of social capital has led researchers to develop and execute qualitative models such as those by Narayan (2000), quantitative designs as in the case of Uphoff (2000), Mahfud et al. (2020), and Chetty et al. (2021), and mixed approaches by Grootaert and Bastelaer (2002). The number and characteristics of the dimensions vary from one researcher to another. For example, Narayan (2001) applied 7 dimensions with 28 items for his investigation, and the research by Grootaert et al. (2004), which serves as a reference framework for the present study, used 6 dimensions with 82 questions. The clusters employed were: groups and networks, trust and solidarity, collective action and cooperation,

information and communication, social cohesion and inclusion, and empowerment and political action. Quantitative research has generally relied on regression analysis, correlations, and structural equation models (Pisani and Micheletti, 2019; Yáñez and Jiménez, 2019).

The last element of study in the research was human capital. Orthodox theory of human capital considers that improving workers' productivity is associated with increased investment in education, thus it is possible to evaluate the relationship between educational levels and the dynamism of economic activities through a correlation between the indicators of these variables. Marginalist theory explains this relationship as the residual of factors of production and national income that cannot be explained simply by a production function that combines labor and capital. Finally, attempts have been made to measure the economic effects of education on income through a rate of return on investment in education resulting from subtracting the earnings of groups of people with higher educational levels from the income of those with fewer educational degrees (Becker, 1964; Ngu, 1982).

However, education is not the only source of human capital accumulation; health care also contributes to human capital (Gümüs and Uysal, 2020). The OECD (2007) defines human capital broadly as the mix of innate skills and abilities of individuals, considering the qualifications and learning acquired through education and training, which also includes health. The return on human capital can be measured in terms of personal benefits and national income.

The **Table 1** summarizes the main theoretical references used in the research to define the factors of the three dimensions utilized in the investigation: endogenous development, social capital, and human capitals, predisposing individuals toward collaboration and cooperation.

Table 1. Factors of endogenous development, human capital, and social capital (Source: Own elaboration).

Dimension	Source	Factors
Human capital	(Becker, 1964)	Their basic approach was to regard education and training as investments made by rational individuals with the purpose of increasing their productive efficiency and incomes.
	(Lewis, 1980)	They considered nutrition and health as determining factors of workers' productivity.
Endogenous development	(Vázquez, 2007)	They posited the accumulation of capital and technological change as the forces driving the processes of growth and structural change in local economies, leading to the conclusion that endogenous development unfolds within the framework of capitalist society.
	(Alburquerque, 2004)	To achieve endogenous local development, decisive aspects include the productive structure, the labor market, existing entrepreneurial capacity, environmental or natural resources, credit systems, social and political structure, as well as historical and cultural heritage, all these elements at the local level.
Social capital	(Grootaert et al., 2003)	They propose the measurement of social capital, both structural and cognitive, with six variables: 1) groups and networks, 2) trust and solidarity, 3) collective action and cooperation, 4) information and communication, 5) social cohesion and inclusion, and 6) empowerment and political action.

2. Materials and methods

The study population consisted of all inhabitants of the municipalities of San Juan Cotzocón and San Pedro y San Pablo Ayutla in the state of Oaxaca, which together totaled 28,060 people in the year 2020 according to data published by The Government of Mexico (2023). The **Table 2** summarizes the operationalization of variables.

Table 2. Operationalization of variables (Source: Own elaboration).

Dimension	Variable	Expression	Items
Social capital	-	CAS	-
	Networks and groups	RyG	I05, I29, I30, I31
	Trust and solidarity	CyS	I09, I34, I35
	Collective action, politics, and cooperation	COL	I38, I39, I44, I45, I46
Human capital	-	CAH	-
	Capabilities and skills	CAP	I10, I18, I19, I21, I32
	Productivity	PRO	I11, I12, I23, I24, I25, I26
Endogenous development	-	DEEN	-
	Identity	IDE	I01, I02, I03, I04, I27, I28
	Heritage	PAT	I06, I07, I08, I17, I20, I37
	Local economic structure	EST	I22, I33, I40, I41, I42, I43
	Employment	EMP	I13, I14, I15, I16, I36

The sample size was determined under the following assumptions: the main variable is qualitative with a finite population and follows a normal or Gaussian distribution (Aguilar, 2005). The formula applied was as follows:

$$n = \frac{N \times Z_{\propto}^2 \times p \times q}{d^2(N-1)Z_{\propto}^2 \times p \times q} \quad (1)$$

where:

n = Sample size;

N = Total population;

$Z_{\propto}$ = Confidence level;

p = Expected proportion;

$q = 1 - p$;

d = Accuracy.

Substituting in Equation (1): N equals 28,060; $Z_{\propto}$ equals 95%; p equals 45%; q equals 55% and; d equals 6%; the sample size resulted in 262 individuals. The probabilistic sample was based on the random selection of members from the study population, for which cartographic and demographic information from the 2020 population and housing census was used. Housing units were identified as the sampling unit, and the inhabitants of each housing unit were surveyed using the questionnaire.

Data processing and analysis were carried out using EFA and SEM. The use of EFA aimed to identify the number of factors or latent variables common from a certain number of items or observable dependent variables in the study (Lloret et al., 2014), prior to this, two tests of sample adequacy were applied: Bartlett's test of sphericity and the Kaiser-Meyer Olkin (KMO) adequacy test. The first test examines the null hypothesis that the analyzed variables are not correlated in the sample, meaning the correlation matrix is an identity matrix, thus, the factorial analysis is not the appropriate method for detecting structures. Small values below 0.05 of the significance level indicate that the factorial analysis may be useful in studying the data (López and Gutiérrez, 2018).

The KMO test assesses the proportion of variance in the variables that may be caused by underlying factors, high values close to 1.0 indicate that the factorial analysis is useful in analyzing the data, on the other hand, values below 0.5 suggest that the factorial analysis is not recommended for that dataset.

SEM models are used for studying causal relationships in non-experimental data, they are a combination of factorial analysis and multiple regression, although they do not prove causality, they allow for selecting relevant causal hypotheses and discarding those not supported by empirical evidence. In experimental research, it is possible to evaluate if one variable precedes another by manipulating the independent variable and controlling the influence of alternative variables through the use of experimental control (León and Montero, 2003).

In non-experimental research, it is not possible to guarantee the directionality and isolation of a relationship since there is no manipulation or experimental control; additionally, in the presence of covariance between two variables, different directions or types of causal relationships can be established, therefore, SEMs start from the premise that covariances provide information about causal relationships through the use of statistical control instead of experimental control; the reasoning consists of decomposing the covariance between variables to obtain information about the parameters of the underlying causal process (Adrián and Muños, 2017).

SEMs consist of two components: the measurement submodel and the structural submodel. The structural submodel allows specifying the hypothetical relationships between latent variables, both endogenous and exogenous (Adrián and Muños, 2017), the equations of the model are established by the following expression (García, 2011):

$$\eta = \beta\eta + \Gamma\xi' + \zeta \quad (2)$$

where:

η: Is a "$p \times 1$" vector of latent endogenous variables;

ξ: Is a "$q \times 1$" vector of latent exogenous variables;

Γ: Is a "$p \times q$" matrix of coefficients that relate exogenous latent variables to endogenous ones;

β: Is a "$q \times q$" matrix of coefficients that relate endogenous latent variables to each other, and;

ζ: Is a "$q \times 1$" vector of errors or disturbance terms.

The measurement submodel describes the relationship between a series of observable variables and the hypothetically constructed construct, mathematically defined as (García, 2011):

$$y = \Lambda_y\eta + \varepsilon \quad (3)$$

$$x = \Lambda_x\xi + \delta \quad (4)$$

where:

y: It is an "$m \times 1$" vector of endogenous latent variables;

ξ: It is a "$k \times 1$" vector of endogenous latent variables;

Λ_y: It is a "$q \times k$" matrix of coefficients of exogenous variables;

Λ_x: It is a "$p \times m$" matrix of coefficients of endogenous variables;

ε: It is a "$p \times 1$" vector of measurement errors for endogenous indicators, and;

δ: It is a "$q \times 1$" vector of measurement errors for exogenous indicators.

The representation of both submodels is commonly carried out through graphs

instead of mathematical equations, to facilitate understanding (Adrián and Muñoz, 2017).

For the purpose of evaluating SEM models, it is generally recommended to estimate identification and examine the fit of the overall model. For the model to be correctly identified, degrees of freedom (*df*) should be calculated, which result from subtracting the number of parameters to be estimated from the number of known elements in the variance-covariance matrix, according to the following formula:

$$df = 1/2 \times ((\text{No. of observed variables}) \times (\text{No. of observed variables} + 1)) - (\text{No. of parameters to be estimated}) \quad (5)$$

Among the indices identified as global fit measures, two types of measures can be distinguished: absolute fit measures and incremental fit measures. The former determines the extent to which the overall model (structural submodel and measurement submodel) predicts the initial data matrix. In this group of absolute measures, the following stand out: the root mean square error of approximation (RMSEA), which measures the discrepancy between the matrix reproduced by the model and the observation matrix in terms of the population rather than the sample; the goodness-of-fit index (GFI), which provides information about the variability explained by the model; the root mean square residual (RMR) and its standardization (SRMR), which show the average difference between predicted variances and covariances and those observed in the model, with a small value reflecting a good fit (García, 2011; Melanie and Amemiya, 2007).

Incremental fit measures aim to ensure that models are simplified approximations of reality, seeking to explain observed behavior. To this end, a series of indicators have been developed to compare the improvement in fit of a model with that of a base or null model (a model with very poor fit) (**Table 3**). Within this family, the following stand out: the normed fit index (NFI), which measures the proportional reduction in fit function when moving from the null to the proposed model; the comparative fit index (CFI), which indicates good model fit for values close to unity; and the adjusted goodness-of-fit index (AGFI), which is the same as GFI but adjusted for the degrees of freedom of the proposed model and the base or null model (García, 2011; Melanie and Amemiya, 2007).

Table 3. Identification and fit measures, and their measurement scale (Source: Developed with information from Melanie and Amemiya (2007) and García (2011)).

Good	**Acceptable**
Sobreidentificado gl > 0	-
$0 \leq RMSEA \leq 0.05$	$0.05 \leq RMSEA \leq 0.08$
$0 \leq RMR \leq 0.06$	$0.06 \leq RMR \leq 0.10$
$0.95 \leq NFI \leq 1.0$	$0.90 \leq NFI \leq 0.95$
$0.97 \leq CFI \leq 1.0$	$0.95 \leq CFI \leq 0.97$
$0.95 \leq GFI \leq 1.0$	$0.90 \leq GFI \leq 0.95$
$0.90 \leq AGFI \leq 1.0$	$0.85 \leq AGFI \leq 0.90$

Based on the endogenous, human, and social factors identified in the literature review, a causal model was constructed that includes observable variables (items),

exogenous latent variables, dimensions (endogenous latent variables), and the variable DECO as the main endogenous latent variable. The hypothesis is that the nine exogenous variables in the model maintain a direct correlation with the dimensions, and consequently with the economic development of the studied municipalities.

Figure 1 shows the 46 items or observable dependent variables of the model (rectangular figures), along with their error terms (en). The nine exogenous latent variables, the three dimensions, and the endogenous latent variable associated with their error term are also represented (circular figures). Unidirectional arrows indicate the relationships between the variables: in the measurement submodel, the items are variables explained by the hypothetical construct and the errors; in the structural submodel, the arrows from the exogenous latent variables point towards the endogenous latent variables to denote, according to the hypothesis, the influence they have on them.

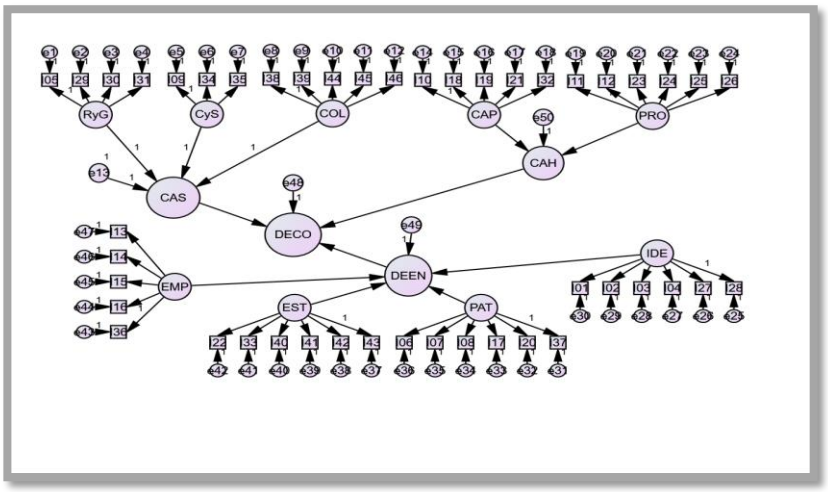

Figure 1. Causal model (Source: Own elaboration).

Reference framework

San Juan Cotzocón and San Pedro y San Pablo Ayutla are municipalities located southeast of the capital of the state of Oaxaca within the Mixe District in the Sierra Norte region of the state. In 2020, they had a population of 28,060 inhabitants (Government of Mexico, 2023). The most representative age group in both municipalities is children and adolescents. 43.5% of the population speaks an indigenous language, mainly Mixe followed by Chinanteco, Zapotec, and Mazatec. Illiteracy is higher in San Pedro y San Pablo Ayutla, with 35.8% of the population, while in San Juan Cotzocón, it is 16.1%. The majority of illiterates are women over 15 years old (Government of Mexico, 2023). The average schooling is 6.8 grades in San Juan Cotzocón and 5.3 in San Pedro y San Pablo Ayutla, both below the state's average of 8.2 grades (Secretaría de Educación Pública, 2023).

In terms of the 2020 Social Marginalization Index, San Juan Cotzocón has a medium marginalization level, while San Pedro y San Pablo Ayutla has a very high marginalization level. Regarding poverty levels, it was observed that 80.2% of the inhabitants of San Pedro y San Pablo Ayutla live in poverty, with 1957 residents in extreme poverty and 2547 in moderate poverty. In the case of San Juan Cotzocón,

74.4% of the population is in poverty, with 6366 residents in extreme poverty and 11,027 in moderate poverty (CONEVAL, 2021).

3. Results and discussion

The structural examination of the data was conducted using the dimension reduction technique, employing maximum likelihood method for extraction and Varimax for orthogonal rotation. Additionally, a criterion was set to eliminate coefficients below 0.35. The results of the two model adequacy tests indicate the relevance of the factor analysis; the KMO test yielded a value of 0.60, and Bartlett's test of sphericity resulted in sig. = 0.00. Furthermore, 6 items were removed from the original database, reducing the number of exogenous latent variables to eight. The resulting model consisted of one endogenous latent variable, three dimensions, eight exogenous latent variables, and 40 items (**Figure 2**).

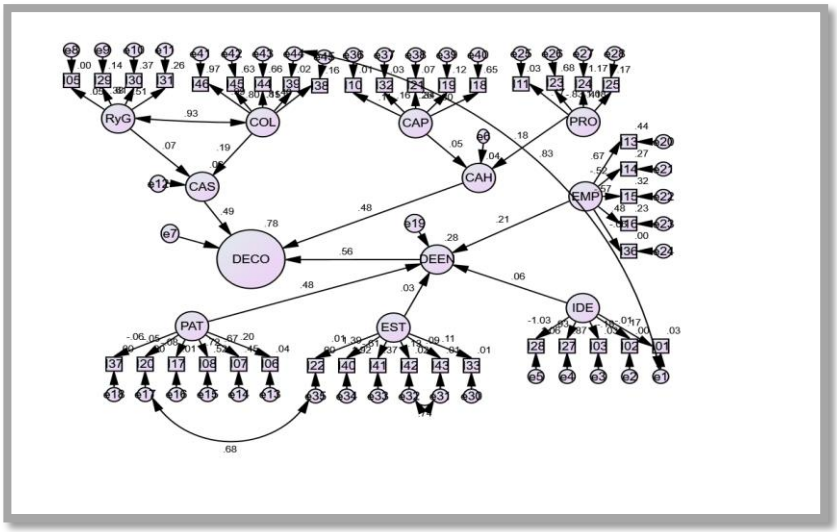

Figure 2. Results of the SEM model estimation (Source: Own elaboration).

The estimation of the SEM model was performed using the maximum likelihood method. The values of the identification and fit indices for the structural submodel and scale submodels are described in **Table 4**. Overall, all eight submodels were found to be overidentified. The structural submodel exhibited indices categorized as good and acceptable, except for RMSEA and AGFI, indicating a discrepancy between the reproduced matrix and the observation matrix, as well as a poor goodness-of-fit index adjusted for the degrees of freedom of the proposed model and the base or null model.

In the case of the scale submodels, the index values ranged between acceptable and good for the CAP, EST, IDE, and PRO submodels. However, for the COL, EMP, RyG, and PAT submodels, there was a failure of estimation in the RMSEA indicator, indicating discrepancies between the reproduced matrix and the observation matrix (**Table 4**).

Table 4. Identification and fit indices of submodels (Source: Own elaboration).

Indicator	Structural submodel	Measurement submodels							
		CAP	COL	EMP	EST	IDE	PAT	PRO	RyG
Identification	776	5	5	5	8	5	10	5	2
RMSEA	0.12	0.05	0.15	0.11	0.04	0.08	0.15	0.00	0.10
RMR	0.00	0.03	0.03	0.04	0.00	0.00	0.00	0.01	0.02
NFI	1.00	1.00	0.94	1.00	0.98	0.97	1.00	0.99	1.00
CFI	1.00	1.00	0.95	1.00	0.99	0.98	1.00	1.00	1.00
GFI	1.00	0.98	0.95	0.96	0.98	0.97	0.91	0.99	0.98
AGFI	0.53	0.96	0.86	0.88	0.96	0.92	0.81	0.98	0.92

The results of the model estimations are presented in **Figure 2**. Regarding the statistical relationships of the measurement submodels, the following effects were identified: items I18 with a value of $\lambda = 0.34$ and I19 with $\lambda = 0.80$, referring to type and place of work respectively, contribute significantly to the formation of the exogenous latent variable CAP. The remaining five items regarding land cultivation, availability to work in maquiladoras, and willingness to change residence were found to be less significant for the formation of the factor. The variable CAP explains little variance in the items, except for I18, which had an $R^2 = 0.65$.

The items I144 with $\lambda = 0.80$, I145 with $\lambda = 0.79$, and I146 with $\lambda = 0.99$, related to cooperative operation, the existence of organizations, and political movements in the community, contributed significantly to the formation of the COL exogenous latent variable, with the explained variance of these items by the construct being $R^2 > 0.60$. The remaining items regarding community celebrations showed no statistical significance in the analysis.

Item I13 with $\lambda = 0.67$, indicating employment status, showed a direct effect on the EPM exogenous latent variable. In contrast, items I14 with $\lambda = -0.52$ and I15 with $\lambda = -0.66$, referring to workplace and job search, exhibited an inverse relationship with the exogenous variable. The rest of the items I16 and I36 concerning time spent searching for work and applying for jobs at the CIIT were less significant; in all cases, the R^2 was below 0.50.

Item I41 with $\lambda = 0.66$, related to the existence of tourist attractions in the community, was the only significant item of the EST construct. The remaining items regarding types of tourist attractions, regional products, and benefits of the CIIT had no significant influence on the exogenous variable; the R^2 was irrelevant for all items.

Items I127 with $\lambda = 0.99$ and I128 with $\lambda = -0.96$, related to speaking an indigenous language, showed a strong factorial loading with the IDE construct, although in the latter case, the relationship was inverse. The remaining items concerning age, gender, and place of residence were not statistically significant, and the explained variance of items I27 and I28 was $R^2 > 0.90$.

Items I107 with $\lambda = 0.67$ and I08 with $\lambda = -0.71$, associated with the number of rooms and people in the household, significantly influenced the PAT variable. The remaining items regarding daily income, property regime, and mode of transportation were not representative in the analysis; the explained variance by the construct was not significant for any of the items.

Item I23 with $\lambda = -0.82$, related to respondent training, was the only one associated with the PRO variable. The remaining items regarding education, training location, and job certification were not significant in shaping the factor; the R^2 value was only significant for I23 with $R^2 = 0.68$.

Items I29 with $\lambda = -0.53$ and I31 with $\lambda = -0.64$, related to family members residing in the USA or living outside the municipality, showed a significant factorial weight in shaping the RyG variable. The remaining items, regarding the number of children and receipt of remittances, were not relevant, with an $R^2 < 0.50$ for all estimated parameters.

The relationship between the three dimensions and the latent variables was established as follows: 68% of the variance of the DEEN dimension was explained by the exogenous variables EMP, IDE, EST, and PAT, with the regression values being: EMP with $\beta = 0.14$, PAT with $\beta = 0.57$, EST with $\beta = 0.57$, and IDE with $\beta = 0.04$. 10% of the variation in the CAS dimension was explained by the RyG and COL variables, with the estimation values being: RyG with $\beta = 0.07$ and COL with $\beta = 0.19$. 5% of the variability of the CAH dimension was explained by the CAP and PRO variables, with the regression values being: CAP with $\beta = 0.05$ and PRO with $\beta = 0.03$.

The structural model solution allowed for the observation that 84% of the variation in the endogenous latent variable DECO is explained by the DEEN, CAS, and CAH dimensions. The effects of the dimensions on DECO were represented by the following values: DEEN with $\beta = 0.71$, CAS with $\beta = 0.41$, and CAH with $\beta = 0.41$.

4. Conclusion

The estimates from the SEM model, based on the database of 262 questionnaires administered during the 2023 survey in the municipalities of San Juan Cotzocón and San Pedro y San Pablo Ayutla in the state of Oaxaca, corroborated the hypothesis regarding the direct influence of the dimensions of endogenous development, social capital, and human capital on the economic development of these municipalities. The variation in the dependent variable was explained by 84% by the model.

The greatest influence is exerted by endogenous development on economic development. According to the estimations, an increase of one unit in the endogenous development variable will result in a growth of 0.71 units in the economic development of the municipalities. The most significant constructs in these terms are employment, identity, local economic structure, and employment. Consequently, the economic development of the municipalities is more precisely influenced by the presence of employment and the type of work performed by citizens (EMP variable). Regarding heritage (PAT variable), the most influential factors are the number of rooms and people in households. In terms of identity (IDE variable), the greatest influence on local development is speaking an indigenous language, and concerning economic structure (EST construct), the greatest impact is exerted by the presence of tourist attractions in the community.

In summary, the municipalities of San Juan Cotzocón and San Pedro y San Pablo Ayutla in the Mixe District of the state of Oaxaca exhibit endogenous, social, and human factors that can drive economic development in their territories. Possibly, the

main trigger for transformation is the existence of tourist and cultural attractions. Therefore, the establishment and operation of the CIIT should favor the development of these municipalities through the construction of roads, airports, and tourist infrastructure to attract national and foreign tourists, resulting in economic benefits for these peripheral communities.

Finally, the limitations of the research should be noted to encourage future studies on the topic. The analysis focused on the municipalities in the lower area of the Mixe District in the Sierra Norte region of the state of Oaxaca, thereby excluding other municipalities located on the periphery of the CIIT, which have their own social and economic dynamics that need to be studied to visualize their development potential within the framework of the Isthmus of Tehuantepec program.

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