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Performance Evaluation of Institutional Capacity Indices in Municipalities of the State of Veracruz, Mexico

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Abstract This study aimed at evaluating the performance of the Municipal Institutional Capacity diagnostic methodologies used in Mexico to determine which has the best theoretical, practical, and technical adjustment in municipalities of the federated state of Veracruz (periods of governance 2018-2021 and 2014-2017). For this research, a mixed, non-experimental, cross-sectional, and correlational research design was employed. The Subnational Analysis method with municipal unit scale was used and content analysis techniques, structured observation, descriptive statistics, and correlation tests were applied. Findings suggest that the Municipal Institutional Development Index showed better overall performance compared to Municipal Functional Capacities Index and Municipal Performance Consultative Guide. The areas of opportunity that were identified in the methodologies include: maximizing the temporal stability and regularity of the measurements (in two cases); the complete contiguity of areas and maximizing the observations (in one case); and, in all three cases, improving the sensitivity of the techniques to the theoretical assumption, as well as strengthening the sustainability approach.

Keywords: • capacity-building • evidence-based policy • municipalities • institutional capacity assessment

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1 Introduction

Although the contemporary municipality in Mexico is the outcome of a gradual and protracted process of expanding functions and authorities, which originated during the colonial period (Valencia Carmona, 2016), its governmental capacity has recently garnered significant attention, particularly regarding its institutionalization and monitoring for improvement. To strengthen the Municipal Institutional Capacity (MIC), there is a federal institutional framework and institutions with jurisdiction in the federated states. Throughout the country, since 2002, this role has been held by the National Institute for Federalism and Municipal Development [Instituto Nacional para el Federalismo y el Desarrollo Municipal (INAFED)], which replaced the National Center for Municipal Development [*Centro Nacional de Desarrollo Municipal* (CEDEMUN)], created in 1989, which in turn replaced the National Center for Municipal Studies [*Centro Nacional de Estudios Municipales* (CNEM)], created in 1984 (INAFED, 2017a). In the federated state of Veracruz of Ignacio de la Llave, it corresponds to the Institute of the federated state of Veracruz for Municipal Development [*Instituto Veracruzano de Desarrollo Municipal* (INVEDEM)] created in 2008 to replace the State Center for Municipal Development, created in 1990 (INVEDEM, s. f.). This function is shared with the Council of the federated state of Veracruz for Democratic Planning for Welfare [*Consejo Estatal de Planeación Democrática para el Bienestar* (CEPLADEB)], formerly the Planning Committee for the Development of the federated state of Veracruz [*Comité de Planeación para el Desarrollo del Estado de Veracruz* (COPLADEVER)].

For their part, INAFED, the Superior Audit of the Federation [*Auditoría Superior de la Federación* (ASF)] and the United Nations Development Program (UNDP) are the main agencies interested in monitoring the MIC in Mexico, therefore, they produce different methodologies, which although they have the same objective, differ in how to carry out this process. These methodologies are relevant as they allow municipal administrations to obtain information for decision-making and because they enable the empowerment of society as a vigilant citizen. This journal manuscript analyzes the MIC diagnostic methodologies proposed by these agents to determine which has the best theoretical, practical, and technical performance in municipalities of the federated state of Veracruz and, therefore, to discover which is more appropriate to formulate rectification strategies for Institutional Capacity Building (ICB) in municipalities, supported by data (*evidence-based policy*).

The research hypothesis *(H_1)* states that the measurement methodologies for CIM exhibit varying levels of theoretical, empirical, and technical performance in the study region. Additionally, three sub-hypotheses have been formulated. The first and second sub-hypotheses are descriptive in nature, whereas the third hypothesis is correlational. The first sub-hypothesis *($H_{1.1}$)* suggests that the methodologies for

measuring MIC demonstrate theoretical conformity, as they align with the capacity components proposed by Grindle & Hilderbrand (1995). The second sub-hypothesis ($H_{1.2}$) posits that the methodologies for measuring MIC show empirical conformity, as they align with the practical criteria for conducting SNR outlined by Harbers & Ingram (2019). Lastly, the third sub-hypothesis ($H_{1.3}$) proposes that the methodologies for measuring MIC are correlated with the development indicator variables, indicating technical conformity.

2 Literature overview

Among the studies that demonstrate interest in the performance of institutional capacities in different parts of the world, we find the following: in Finland, Nordberg (2020), focused on the spatial distribution of capacities; in Colombia, Jonkman (2019); in the United States, Garrick et al. (2013) and Lindbergh et al. (2022); in Israel, Segal et al. (2022); in Thailand, Singh et al. (2021); in the United Kingdom, Bennett et al. (2004) and MacKinnon & Phelps (2001); in Australia, Mitchell et al. (2015); in Vietnam, Nguyen et al. (2022) and Tran & Rodela (2019); in Tanzanian, Hyden (1990) and Smucker et al. (2015); in Indonesia, Mahdi et al. (2017), Sidabutar et al. (1991), and Bebbington et al. (2006); in Zambia, Nansikombi et al. (2020); in Brazil, Selva et al. (2020); in Ghana, Volsuuri et al. (2022); and in China, Wang et al. (2017). In Mexico, studies on Municipal Institutional Capacity (MIC) vary in their scope. Some studies consider all the responsibilities under the municipality's jurisdiction (Cabrero Mendoza, 2004; Moreno Jaimes, 2008; Orozco Villafañe et al., 2018; Rosas Huerta, 2008, 2019), while others focus on specific areas of municipal work (Arroyo Alejandre & Guzmán Flores, 2008; Bojórquez Carrillo et al., 2015; Domínguez Serrano, 2010; Gargantini & Pedrotti, 2018; Guzmán Gil & Becerril Sánchez, 2019; Hernández Valdez, 2017; Martínez Tiburcio & Cabrera Hernández, 2018; Montijo Galindo & Ruiz-Luna, 2018; Ochoa-Martínez et al., 2016; Pineda Pablos et al., 2019; Romo de Vivar Mercadillo & Gómez Monge, 2016; Salazar Adams et al., 2020; Unda Gutiérrez, 2018).

Specifically, regarding Institutional Capacity Indices and their evaluation, the following quantitative studies on Institutional Capacity were found: Wagner & Whetsell (2023) developed a national research capacity index, while Acimovic & Goentzel (2016) proposed Metrics to Assess Humanitarian Response Capacity based on stochastic optimization models. These studies have an international scope. Additionally, case studies were also identified, such as Fincham (2020) development of a Resilience Capacity Index (RCI) for food insecurity in Malawi, and Clare et al. (2018) study in Kyrgyzstan, which claims to be the first to quantitatively compare the power of subjective and objective resilience measures in predicting future household food security and well-being. Furthermore, employing a qualitative approach, the study titled "Stakeholder engagement affects the quality

and performance of a policy" (Marzaniar & Subarsono, 2023) was found in Indonesia. Since no exercises were found to compare the performance of indicators of municipal government capacity with a quantitative approach and emphasis on all functions, a research gap was identified to be addressed.

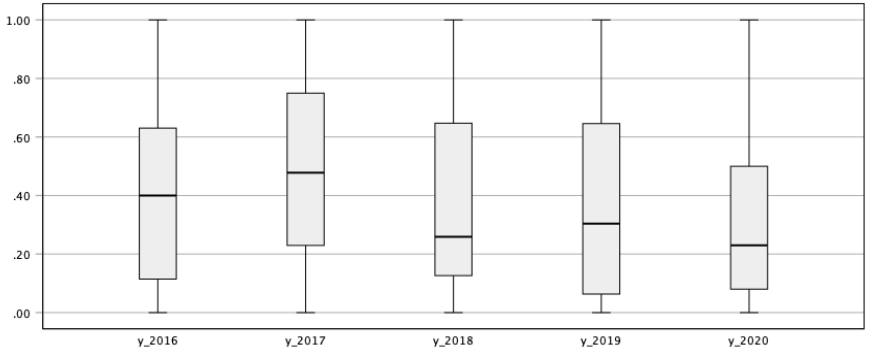
In Mexico, the institutionalization of the building of MIC is linked *de iure* to INAFED, with national competence, and INVEDEM, with competence in the Region of Study (RoS). *De facto*, it is monitored by INAFED, the ASF and UNDP. Sections 2.1, 2.2, and 2.3 explain the methodologies developed by these institutions to measure the institutional capacities of municipalities in Mexico. This study covers until January 2023.

2.1 INAFED programs

INAFED has been promoting the evaluation of MIC since 2004, with three annual updating methodologies that replaced each other (the Municipal Performance Consultative Guide [*Guía Consultiva de Desempeño Municipal*] to the Municipal Development Agenda Program [*Programa Agenda para el Desarrollo Municipal*], which replaced the Local Agenda Program [*Programa Agenda desde lo Local*]). The periods of validity of these 3 programs can be consulted in Table 1.

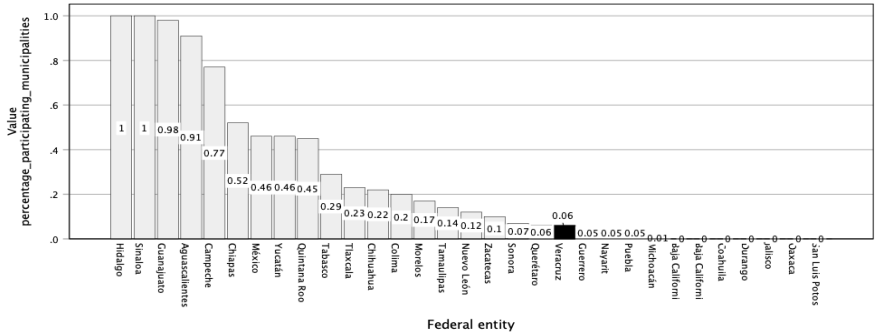
The participation of municipalities in INAFED programs is voluntary. At the national level, a decrease was observed in the last 6 years (Figure 1a). In the RoS, participation began in 2011 and, after ten years, it has not been consolidated (Figure 2). In 2012 and 2013, the largest increase was presented and thereafter a downward trend with a slight rebound in 2021 (last update published), reaching a coverage of 6% of the RoS (13 municipalities). This has caused Veracruz to be one of the federated states with the lowest participation (Figure 1b).

Figure 1a: Participation of federal states in INAFED programs for MIC monitoring (2016-2021)



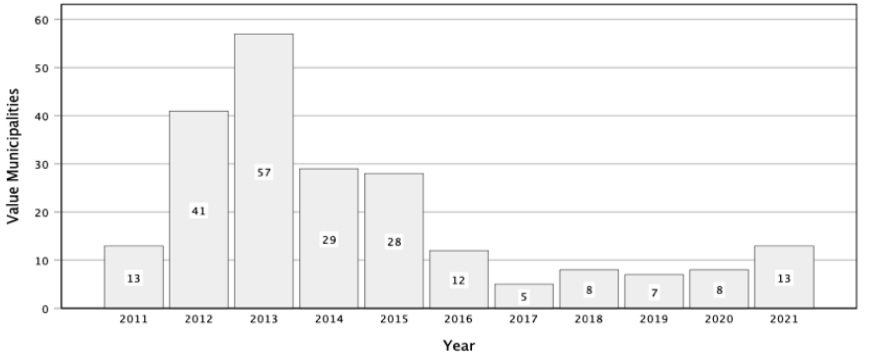
Source: Authors' own elaboration based on INAFED (s. f., 2016, 2017b, 2018). Designed on SPSS.

Figure 1b: Participation of the municipalities of the federated state of Veracruz in the GDM (2021)



Source: Authors' own elaboration based on INAFED (s. f.). Designed on SPSS.

Figure 2: Municipalities of the federated state of Veracruz participating in INAFED programs for MIC monitoring (2011-2021)



Source: Authors' own elaboration based on INAFED (s. f., 2013, 2014, 2015, 2016, 2017b, 2018). Designed on SPSS.

2.2 Municipal Institutional Development Index of the ASF

The ASF, in charge of supporting the Chamber of Deputies of the Congress of the Union [*Cámara de Diputados del Congreso de la Unión*], to monitor that the federal public resource is provided in accordance with the legislation, has a special interest in the MIC as in the audits of the resources exercised by the municipalities the observations for poor handling are recurrent (ASF, 2015). It argues that the MIC affects the quality with which municipalities manage resources and, to support their strengthening, it implements a diagnostic methodology: The Municipal Institutional Development Index [Índice de Desarrollo Institucional Municipal (IDIM)], which was first published in 2015, and is updated in non-regular periods. The IDIM has information from the 212 municipalities of the RoS in two data sets: 2013, published in 2015, and 2019, published in 2022 (Table 1). The scale of the IDIM is from 0 to 1, in which a higher value represents better capacities.

2.3 UNDP Municipal Functional Capacities Index

Developing IC to build a better life is among UNDP goals (2022). This goal is achieved in the "human development approach based on capacity development", (UNDP, 2009) which seeks to enable people, organizations and societies to build, strengthen and maintain the skills necessary to formulate and achieve their objectives. When referring specifically to the government's management skills "that enable the planning, implementation, monitoring and evaluation of growth initiatives"(UNDP, 2009, p. 17), they are called "functional capacities" (UNDP, 2009); hence the name of its diagnostic methodology: Municipal Functional

Capacities Index [*Índice de Capacidades Funcionales Municipales* (ICFM)]. The ICFM is a composite indicator, its scale is from 0 to 1, in which a higher value means better functional capacities. There is only one edition, published in 2019 with data gathered in 2017. It has information from the 212 municipalities of the RoS (Table 1). In addition, an update is expected to be published in 2023. The Sustainable Development Goals (SDGs) also recapture this capacity-building approach in developing countries (SDG 17), as well as in institutions at all levels of government (SDG 16).

2.4 Summary of the properties of the three methodologies

INAFED develops diagnostic methodologies on a mixed basis with qualitative preponderance, based on a categorization by scales in traffic light format, which are mostly fed by records of dichotomous variables (they are recorded as 1 when the attribute is presented, and as 0 when it is not presented); while the ASF and UNDP develop quantitative methodologies based on composite indicators (Table 1).

Composite or synthetic indicators are utterly useful in decision-making for their ability to synthesize, ease of interpretation and comparability (Schuschny & Soto de la Rosa, 2009). The IDIM, as well as the ICFM are composite indicators. The GDM does not integrate a global indicator as suggested by Schuschny & Soto de la Rosa (2009), but is limited to building sub-indicators (8 modules composed of 115 indicators (INAFED, s. f.) (Appendix 1).

On the other hand, it is important to mention that the MIC diagnoses are made from two different perspectives: examining all the responsibilities in their charge, or with an emphasis on some specific area of work, such as flood (Ochoa-Martínez et al., 2016) or drought risk management (Salas-Martínez et al., 2021). In this article, the diagnoses of MIC are addressed, considering the responsibilities in general.

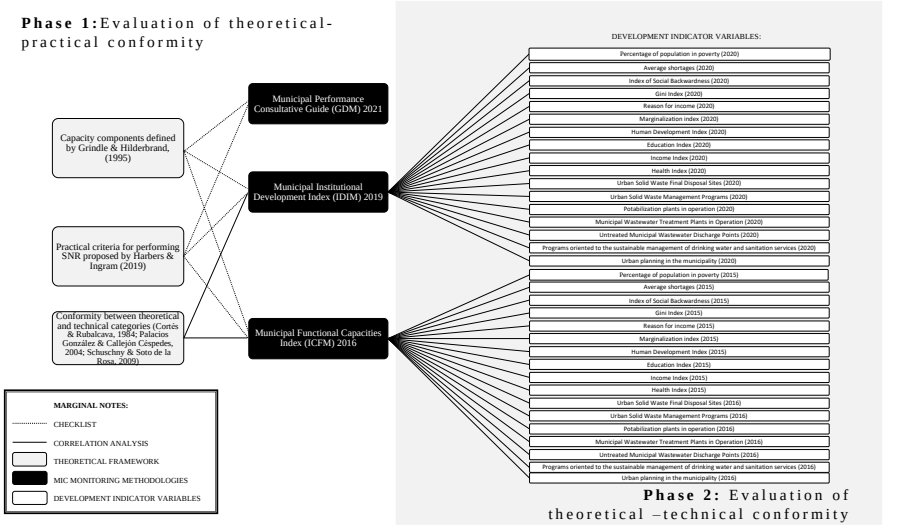
3 Research

A non-experimental, cross-sectional research design with a mixed approach and correlational scope was defined and Subnational Research (SNR) was used (Giraudy et al., 2021) with a scale of municipal units: the 212 municipalities of the federated state of Veracruz, Mexico in the periods of governance 2018 - 2021 and 2014 - 2017. Content analysis, structured observation, descriptive statistics, and correlation analysis were employed.

First, the agents interested in monitoring the MIC in the RoS and the methodologies they proposed for this purpose were identified. Subsequently, according to the research design (Figure 3) the theoretical conformity of the methodologies was analyzed using the capacity components defined by Grindle & Hilderbrand (1995)

as a reference, and the conformity of the databases with the practical criteria for performing SNR proposed by Harbers & Ingram (2019) was evaluated.

Figure 3: Research design: phases and diagram of relationship between variables



Source: Authors' own elaboration based on Grindle & Hilderbrand (1995), Harbers & Ingram (2019), INAFED (2022a), ASF (2022), UNDP (2019), CONEVAL(2021, s. f.-a, s. f.-b), CONAPO (2021), ASF (2015, 2022), UNDP (2019, s. f.), and INEGI (2017, 2022).

Consequently, the distribution of the data was analyzed and the most appropriate correlation test was selected and carried out to evaluate the conformity between theoretical and technical categories used to treat the problem (Cortés & Rubalcava, 1984; Palacios González & Callejón Céspedes, 2004; Schuschny & Soto de la Rosa, 2009) in the *RoS; in the case in question, the conformity between the theoretical assumption "institutional capacities are enabling development*" (Completa, 2017; Fiszbein, 1997; Moreno Jaimes, 2007) and the MIC monitoring methodologies. The selection of development indicator variables was based on the criteria of theoretical correspondence, complete coverage in the RoS, level of municipal disaggregation, and maximum closeness with the data collection of the MIC diagnostic methodologies; as well as on the principle of exhaustiveness in the search for information in the public databases of the National Institute of Statistics and Geography [Instituto Nacional de Estadística y Geografía (INEGI)], the National Council for the Evaluation of Social Development Policy [Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL)], the National

Population Council [Consejo Nacional de Población (CONAPO)], and the United Nations Development Program (UNDP). As a result, 17 development indicator variables were selected in their environmental, economic, and social dimensions (Table 2). The criterion used to select the temporary cuts was the most recent update in the case of the capacity indices (IDIM 2019 and ICFM 2016), and the greater proximity of the data collections of the development indicator variables with these updates (2020 in the case of IDIM 2019 and 2015 and 2016 in the case of ICFM 2016, according to the updating periods of the data source programs).

Finally, calculations of the correlations were performed (Figure 3) using IBM SPSS Statistic version 29.0.0.0 (241) for Apple macOS. Hypothesis tests were performed to give statistical significance to the results. From the results, the conformity of the measurement techniques with the theoretical assumptions was determined.

4 Discussion (Performance Evaluation Results)

4.1 Theoretical conformity assessment

This section analyzes the conformity of the methodologies for evaluating MIC (GDM, IDIM and ICFM) with the theoretical conceptualization of IC with a focus on constitutive factors (Completa, 2017; Rosas Huerta, 2008). According to Schuschny and Soto de la Rosa (2009), this exercise is essential in order to know if the methodologies cover the main dimensions of the object of study and show something representative about the question to be studied; in our case, the MIC. Considering it one of the most detailed conceptualizations, the 19 capacity components that according to Grindle & Hilderbrand (1995) affect capacity building were used as references (*capacity-building, capacity development or capacity strengthening*). These capacity components can limit or facilitate the performance of certain tasks; they were compared with the diagnostic methodologies (Table 3).

Although there is a different level of conformity, the three methodologies incorporate elements of the five dimensions of Grindle & Hilderbrand (1995). The highest compliance with the theoretical conceptualization is with the GDM (with 16 components), followed by the ICFM (13 components), and the lowest compliance corresponds to the IDIM (with 11 components).

4.2 Evaluation according to the practical criteria to perform SNR

With the support of Table 4, the compliance of methodologies databases with the practical criteria for performing SNR proposed by Harbers & Ingram (2019) in the RoS was analyzed. Unlike the exercise carried out by Lagunes-Gómez et al. (2022), the 2019 update of the IDIM published in February 2022 is included (ASF, 2022).

The maximum conformity with the practical criteria to perform SNR in the RoS was found in the IDIM and the ICFM, above the INAFED programs. This difference is mainly because while the IDIM and the ICFM have data from all the municipalities of the RoS, the GDM does not (Table 1).

4.3 Conformity assessment of the techniques used with the theoretical assumptions

Based on the assumption that the well-being and improvement of the quality of life are objectives of the States at their different levels of government and that the success or failure in the search for these depends on their management skills (Completa, 2017), in this section the adequacy between theoretical and technical categories used to address the problem will be evaluated (Cortés & Rubalcava, 1984; Palacios González & Callejón Céspedes, 2004; Schuschny & Soto de la Rosa, 2009). In this case, the theoretical categories to be analyzed are MIC and development; while the techniques to be analyzed are: IDIM, ICFM and GDM.

When data from the entire population is not available and a sample has to be worked with, it must be representative, have an adequate level of confidence, and not exceed the maximum error of estimation (Vivanco, 2005). Since the GDM and its predecessors do not have data from all the municipalities of the RoS, an adequate sample size was calculated using the formula [1] and considering a population (N) of 212 municipalities, a confidence level (Z) of 95%, a margin of error (c) of 0.05, and a standard value of p = 0.5 (commonly used when there is no background on the research carried out).

$$Sample\ size = Z^2 p \frac{(1-p)}{c^2} \quad [1]$$

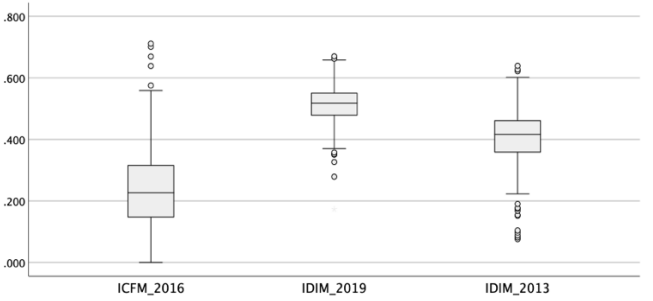
According to the calculation, a statistically representative sample of the RoS, within the parameters of acceptable confidence and error, it must have at least 137 municipalities; since the largest participation in the RoS in 2013 reached only 57 municipalities (Figure 2): the amount of data available is insufficient. Consequently, as our main objective is to identify the most appropriate methodology to formulate MIC rectification strategies throughout the RoS, the GDM and its predecessors are discarded as an option and the empirical performance of the IDIM and the ICFM is evaluated to determine if there is any significant difference in their effectiveness.

Although there are differences in the state and national averages of the ICFM and the IDIM, in both cases the values are distant from reaching unity (1), evidencing

challenges in the management of MIC in the RoS and in the country in general (Table 5). Since both indices use different calculation methodologies (see Appendix 2) they are not comparable to each other, so the basic statistics to notice differences and similarities will be analyzed.

In general, the IDIM reports higher MIC values than the 2016 ICFM (Figure 4). As can be seen in Table 6, the data range is higher in the 2016 ICFM (0.71126); this indicates that the data are more dispersed than in the 2013 IDIM (0.56340), and that in the 2019 IDIM (0.49700), this can be corroborated in the standard deviation, as well as in Figure 4.

Figure 4: Tukey-style box and whiskers plot. 212 municipalities of the federated state of Veracruz, Mexico
ICFM 2016 and IDIM 2019, 2013



Source: Authors' own elaboration based on UNDP (2019) and ASF (2015, 2022). Designed on SPSS.

Based on the theoretical assumption that *institutional capacities are enablers of development*, the existence of some significant difference in the performance of both indices in the RoS was determined by evaluating the correlation of the 2016 ICFM and the 2019 IDIM (as MIC indicators) with the development indicators (as theoretical effects of the IC). To select the most appropriate correlation test, a data normality test was performed using the Kolmogorov-Smirnov goodness-of-fit test as the most recommended for the sample size (Fau-Fuentes et al., 2020; Galindo Domínguez, 2020; Pedrosa et al., 2015; Saldaña, 2016). Spiegel & Stephens (2009) report that *data do not follow a normal distribution* when the *p-value* < 0.05, whereas, when *p-value* ≥ 0.05 *a normal distribution* is accepted.

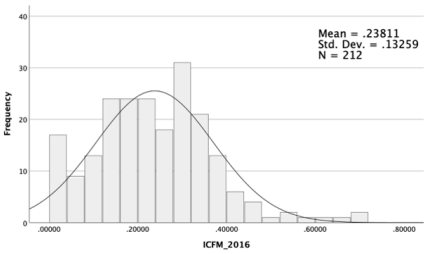
The Kolmogorov-Smirnov statistic with Lilliefors significance correction was calculated in SPSS considering a 95% confidence level (*NC*) and a margin of error of 0.05 (Table 7 and Table 8). Although the data processing in all cases was done with 212 municipalities, the information from the databases yielded 211 valid data,

in the case of the variables that were analyzed against the 2016 ICFM, and 190, in the case of those analyzed against the 2019 IDIM.

When contrasting the results with the *p-value* test statistic (*Sig.*); for the 2016 ICFM (0.045) and the 2019 IDIM (0.002) the normal distribution is rejected and the non-normal distribution is accepted, as in both cases *p-value* < 0.05. This non-normal distribution can be checked graphically in Figure 5a, 5b, 5c, and 5d.

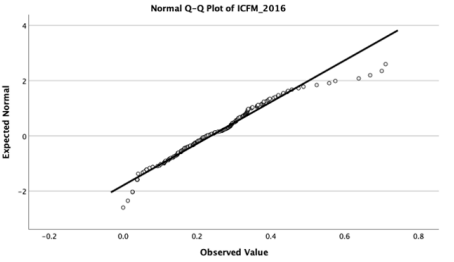
Figure 5: Histogram and Normal Q-Q Plot. Municipalities of the federated state of Veracruz, Mexico. ICFM 2016 and IDIM 2019

5a)



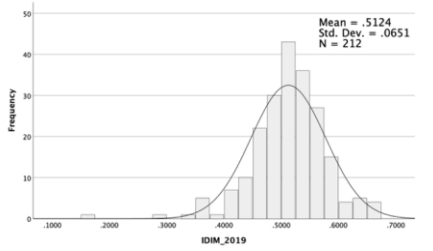
Source: Authors' own elaboration based on UNDP (2019).
Designed on SPSS.

5b)



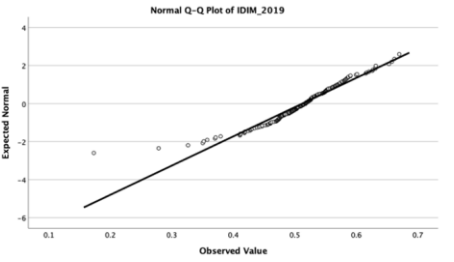
Source: Authors' own elaboration based on UNDP and ASF(2019).
Designed on SPSS.

5c)



Source: Authors' own elaboration based on ASF (2022).
Designed on SPSS.

5d)



Source: Authors' own elaboration based on ASF (2022).
Designed on SPSS.

According to Vilalta (2016), the measurements and inferences in social research must be appropriate with the precise definition of the phenomenon and the observed data. This implies leaving aside the assumption of theoretical or expected

parameters (in this case, the normal distribution) when there is not intuitively logical, theoretical, or even minimally empirical basis for assuming such behavior. In this case, it is suggested not performing transformation or normalization and making point estimates based on parameters derived from the observed sample distributions. Therefore, the distribution of the data rules out the Pearson Correlation as an adequate test, since it requires that the joint distribution be bivariate normal (Restrepo B & González L, 2007) and supports its non-parametric, free distribution and appropriate alternatives to quantitative variables: the Spearman correlation coefficient and the Kendall Tau coefficient (Ardila, 1966; Caycho Chumpitaz et al., 2019).

For the calculation of the correlations between the 2016 ICFM and the development indicator variables (Appendix 3a), and between the 2019 IDIM and development indicator variables (Appendix 3b), the Spearman Rho correlation coefficient (ρ) was used as it is the most widely used (Johnson & Kuby, 2012; Restrepo B & González L, 2007; Spiegel & Stephens, 2009). To obtain greater objectivity, no sense of direction was assumed in the expected behavior, being the existence of association the only theoretical assumption that was formulated as an alternative hypothesis. Thus, according to Johnson & Kuby (2012) and Mendenhall et al. (2010) a statistical significance test of ρ was performed for a two-tailed hypothesis [The null hypothesis of non-correlation ($\rho = 0$), and the alternate hypothesis *($H_{1.3}$)* of correlation ($\rho \neq 0$)] (Table 9). The critical region (ρ_c) was estimated using the Spearman Critical Correlation Calculator available at https://mathcracker.com/en/Spearman-Critical-Correlation-Calculator#results.

Hypothesis test ($H_{1.3}$) showed that ρ is significantly different from 0 at the significance level 0.05, in 4 of the 17 associations explored with the 2016 ICFM, and in 13 of the 17 associations explored with the 2019 IDIM (Table 9 and Table 10). The IDIM also demonstrated higher correlations than the ICFM (Table 9 and Table 10), and both demonstrated significant correlation with Potabilization Plants in Operation (PpeO) and Gini Coefficient (CGINI).

Based on the statistical evidence, it is argued that there are considerable differences in the technical-theoretical conformity of both indices. The IDIM performed better since it demonstrated higher statistically significant associations and higher intensity in associations in the RoS (Table 9).

The associations found in the correlations highlighted two relevant findings that are not part of the main objective of this study, however, they are worth. First, the results show that, although there is a correlation between the MIC and the variables indicating environmental commitment, this is practically nil [in accordance with the proposal of Gutiérrez Pulido & Vara Salazar (2009); they can be consulted in Appendix 4]: the level of the MIC did not prove to be associated with an evident

interest in having: Wastewater Treatment Plants in Operation ($\rho = 0.317$), Potabilization Plants in Operation ($\rho = 0.208$), or *Programs Oriented to the Sustainable Management of Drinking Water and Sanitation Services 2020 (*$\rho = 0.137$*).* In the case of Urban Solid Waste Final Disposal Sites, Urban Solid Waste Management Programs, or Programs Oriented to the Sustainable Management of Drinking Water and Sanitation Services, a significantly different correlation of 0 at the 0.05 significance level was not evidenced in 2020. It is most alarming that the number of untreated Municipal Wastewater Discharge Points ($\rho = 0.183$), which theoretically should be negatively correlated with the MIC, i.e., the higher the MIC, the lower the number of untreated Municipal Wastewater Discharge Points, empirically demonstrated a significant positive correlation.

Second, income per person showed associations from *strong to very strong* ($-0.85 \leq \rho \geq 0.85$) with composite calculation indicators of well-being and quality of life in the 2015 temporary cut-off and in the 2020 temporary cut-off (Appendix 2a and 2b); while the variables indicating inequality in the income distribution (such as the Gini coefficient and Reason for income) did not show such strong associations (Appendix 2a and 2b). This result is consistent with the *Latin American Economic Outlook 2019* study (CEPAL, 2019), which describes the relationship between per capita income and various development indicators in Latin America and the Caribbean as "imperfect"; where the relationship in countries with low-income economies is strong and weakens as countries transition to higher-income economies.

5 Conclusions

Based on the findings, the research hypothesis (H1) is accepted, providing evidence that the measurement methodologies for MIC exhibit different levels of theoretical, empirical, and technical performance within the study region. The Municipal Institutional Development Index (IDIM) of the ASF demonstrated the best overall performance in the tests of theoretical conceptualization, as well as in the tests of practical criteria to perform SNR in the RoS. In addition, the IDIM demonstrated a greater adequacy of the technique with the theoretical assumption. The Municipal Functional Capacity Index (ICFM) of the UNDP demonstrated the second-best performance, and the INAFED Municipal Performance Consultative Guide (GDM) the third. The main factors that defined a better performance of the IDIM compared to the ICFM are that it has two data takes compared to one of the ICFM and that it demonstrated greater association and strength in the association with the developmental indicator variables in the RoS. On the other hand, although the maximum theoretical compliance was obtained by the GDM, it also demonstrated the lowest compliance with the practical criteria for performing SNR and insufficiency to integrate a statistically representative sample, with acceptable confidence and error parameters.

This study represents the first documented effort to evaluate MIC measurement methodologies. The information it provides is of both academic and practical value, as it supports a central function in the theory and practice of development management: capacity-building or capacity development. The objective of this study was to enhance understanding of MIC diagnostic methodologies in the RoS and guide the formulation of rectification strategies based on data. It is important to acknowledge that the findings are specific to the RoS, as well as the variables and time periods of the research design, and they do not claim universal validity. However, the study can be replicated in other temporal and local territorial contexts (municipal, regional) and also at the national level.

The results showed that the three methodologies have important challenges to overcome: in the case of the IDIM and the ICFM, the maximization of the temporal stability and regularity of the measurements (since they enable or limit the realization of transversal studies and monitoring), as well as improving the sensitivity of the techniques used in the measurement of the MIC against the theoretical assumption. In the case of the GDM, achieving complete contiguity of areas and maximizing the observations in the RoS, for which it is necessary to promote the participation of the municipalities, strengthen the alliances with the INVEDEM, and encourage the participation and commitment of the academic sector. In addition, it is essential to move towards a paradigm of sustainable municipal development in the RoS, since empirically the Municipal Institutional Capacity did not demonstrate relevant associations with environmental benefits, which evidences an extractive municipal development paradigm. Consequently, it is important to redouble efforts to strengthen methodologies, since they depend on the quality of information offered to society to assume monitoring functions and accountability, as well as to generate more accurate interventions for the building of MIC, based on the principle of special and differentiated treatment, which is recognized as core in both the Sectorial Governance Program 2020-2024 and the Sustainable Development Goals (SDGs).

In sum, we believe that the use of each methodology should be evaluated based on the study for which it will serve as support. For example, the use of the IDIM (and as a second option, the ICFM) is recommended when carrying out studies that require data from the maximum number of municipalities, such as regionalization and diagnosis studies, monitoring, and evaluation of development planning throughout the RoS. While the use of information from INAFED programs is recommended only in the diagnoses of municipal development planning (general and in specific areas) and in case studies if recent information is available (Appendix 4).

In conclusion, we have valid reasons for choosing IDIM 2019 as the most suitable MIC measurement methodology for further research. It will help us gain a deeper understanding of MIC, identify gaps and inequalities, and develop evidence-based policy for capacity building. Additionally, we consider it important to study the spatial distribution of MIC levels using Exploratory Spatial Data Analysis (ESDA) to better understand their territorial patterns. Furthermore, the potential for data-driven regional modeling strategies applied to capacity-building should be explored.

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Notes:

Based on the findings of this study, as further research we consider it appropriate to carry out autocorrelation studies to explore changes in the MIC over time, considering at least the two editions of the IDIM (2013 and 2019) and, in the case of the ICFM, the 2016 and the update announced to be published in 2023; as well as studies with a focus on inequality and explanatory factors in the RoS.

References:

Acimovic, J. & Goentzel, J. (2016) Models and metrics to assess humanitarian response capacity, *SSRN*, https://doi.org/10.2139/ssrn.2584560.

Ardila, R. A. (1966) Técnicas estadísticas no paramétricas, *Revista Colombiana de Psicología*, 11(1-2), pp. 89-102.

Arroyo Alejandre, J. & Guzmán Flores, J. (2008) Capacidades institucionales en los municipios en la promoción económica local, *Carta Económica Regional*, 100, pp. 7-30.

ASF (2015) Desarrollo Institucional Municipal, *Auditoría Superior de la Federación*, available at: http://200.23.8.25/ASF/?m=bWVudSww (December 26, 2022).

ASF (2022) Informe del Resultado de la Fiscalización Superior de la Cuenta Pública 2020. Índice de Desarrollo Institucional Municipal (SEPARATA), *ASF*, available at: https://www.asf.gob.mx/Trans/Informes/IR2020c/index.html#0 (December 26, 2022).

Bebbington, A., Dharmawan, L., Fahmi, E. & Guggenheim, S. (2006) Local Capacity, Village Governance, and the Political Economy of Rural Development in Indonesia, *World Development*, 34(11), pp. 1958-1976, https://doi.org/10.1016/j.worlddev.2005.11.025.

Bennett, R. J., Fuller, C. & Ramsden, M. (2004) Local government and local economic development in Britain: An evaluation of developments under labour, *Progress in Planning*, 62(4), pp. 209-274, https://doi.org/10.1016/j.progress.2004.07.003.

Bojórquez Carrillo, A. L., Manzano Loría, M. E. & Uc Heredia, L. J. (2015) Análisis de la relación entre la capacidad administrativa y la transparencia en gobiernos locales en México, *Investigaciones Regionales - Journal of Regional Research*, 31, pp. 101-118.

Cabrero Mendoza, E. (2004) Capacidades institucionales en gobiernos subnacionales de México ¿Un obstáculo para la descentralización fiscal?, *Gestión y Política Pública*, XIII(3), pp. 753-784.

Caycho Chumpitaz, C. T., Merino Escalante, V. & Castillo Crespo, C. H. (2019) Manual de estadística no paramétrica aplicada a los negocios, *En Repositorio Institucional—Ulima*, 1a edición, (Lima: Universidad de Lima, Fondo Editorial), availabe at: https://repositorio.ulima.edu.pe/handle/20.500.12724/9349 (December 12, 2022).

CEPAL (2019) *Perspectivas económicas de América Latina 2019: Desarrollo en transición* (Paris: CEPAL), available at: https://www.cepal.org/es/publicaciones/44525-perspectivas-economicas-america-latina-2019-desarrollo-transicion (December 29, 2022).

Clare, A., Sagynbekova, L., Singer, G., Bene, C. & Rahmanberdi, A. (2018) *Can subjective resilience indicators predict future food security? Evidence from three communities in rural Kyrgyzstan* (London: Centre for Climate Change Economics, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science), available at: https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2018/11/working-paper-308-Clare-et-al.pdf (July 17, 2023).

Completa, E. R. (2017) Capacidad Estatal: ¿Qué Tipo De Capacidades Y Para Qué Tipo De Estado?, *Revista POSTData: Revista de Reflexión y Análisis Político*, 22(1), pp. 111-140.

CONAPO (2021) *Índices de marginación 2020*, available at: http://www.gob.mx/conapo/documentos/indices-de-marginacion-2020-284372 (December 24, 2022).

CONEVAL (2022) Cohesión Social, *Medición de la pobreza*, available at: https://www.coneval.org.mx/Medicion/Paginas/Cohesion_Social.aspx (December 24, 2022).

CONEVAL (2022) *Índice de Rezago Social 2000-2020*, available at: https://www.coneval.org.mx/Medicion/IRS/Paginas/Indice_de_Rezago_Social_2020_anexos.aspx (December 24, 2022).

CONEVAL (2021) *Medición de la pobreza, Estados Unidos Mexicanos, 2010-2020, Indicadores de pobreza por municipio*, available at: https://www.coneval.org.mx/Medicion/Paginas/Pobreza-municipio-2010-2020.aspx (May 7, 2022).

Cortés, F. & Rubalcava, R. M. (1984) *Técnicas estadísticas para el estudio de la desigualdad social*, 2a ed. (Mexico: Colegio de México, Facultad Latinoamericana de Ciencias Sociales, Centro de Estudios Sociológicos).

Domínguez Serrano, J. (2010) El acceso al agua y saneamiento: Un problema de capacidad institucional local. Análisis en el estado de Veracruz, *Gestión y política pública*, 19(2), pp. 311-350.

Fau-Fuentes, C., Nabzo, S. & Nasabun, V. (2020) Bondad de ajuste y análisis de concordancia, *Revista Mexicana de Oftalmología*, 94(2), p. 3414, https://doi.org/10.24875/RMO.M20000107.

Fincham, A. (2020) *Modelling Resilience to Food Insecurity Malawi Case Study* [Degree of MCom (Quantitative Management)] (South Africa: Stellenbosch University), available at: https://scholar.sun.ac.za/items/5b3ef6ca-b5ea-4a90-a763-dfcee208a010 (July 17, 2023).

Fiszbein, A. (1997) The Emergence of local capacity: Lessons from Colombia, *World Development*, 25(7), pp. 1029-1043, https://doi.org/10.1016/S0305-750X(97)00020-X.

Galindo Domínguez, H. (2020) *Estadística para no estadísticos: Una guía básica sobre la metodología cuantitativa de trabajos académicos*, 1ª ed. (Alicante: Editorial Científica 3Ciencias), https://doi.org/10.17993/EcoOrgyCso.2020.59.

Gargantini, D. M. & Pedrotti, C. I. (2018) Capacidades institucionales del gobierno municipal en el diseño y gestión de políticas habitacionales, *Economía, sociedad y territorio*, 18(57), pp. 319-357, https://doi.org/10.22136/est20181131.

Garrick, D., Whitten, S. M. & Coggan, A. (2013) Understanding the evolution and performance of water markets and allocation policy: A transaction costs analysis framework, *Ecological Economics*, 88, pp. 195-205, https://doi.org/10.1016/j.ecolecon.2012.12.010.

Giraudy, A., Moncada, E. & Snyder, R. (2021) El análisis subnacional: Aportes teóricos y metodológicos a la política comparada, *Revista de Ciencia Política (Santiago)*, 41(1), https://doi.org/10.4067/S0718-090X2021005000107.

Grindle, M. S. & Hilderbrand, M. E. (1995) Building sustainable capacity in the public sector: What can be done?, *Public Administration and Development*, 15(5), pp. 441-463, https://doi.org/10.1002/pad.4230150502.

Gutiérrez Pulido, H. & Vara Salazar, R. de la. (2009) *Control estadístico de calidad y seís sigma*, 2a ed. (Mexico: McGraw-Hill).

Guzmán Gil, P. D. & Becerril Sánchez, T. (2019) El desarrollo de capacidades institucionales ante los retos de la coordinación metropolitana en México: El caso de Toluca, *Decumanus*, 4(4), https://doi.org/10.20983/decumanus.2019.1.1.

Harbers, I. & Ingram, M. C. (2019) Politics in Space: Methodological Considerations for Taking Space Seriously in Subnational Research, In: Giraudy, A., Moncada, E. & Snyder, R. (eds.) *Inside Countries: Subnational Research in Comparative Politics* (Cambridge: Cambridge University Press), pp. 57-91, https://doi.org/10.1017/9781108678384.002.

Hernández Valdez, A. (2017) *Capacidades institucionales para la gobernanza en las zonas metropolitanas de Ocotlán, Ciudad Guzmán y Puerto Vallarta, Jalisco* (ONU-Habitat), available at: https://publicacionesonuhabitat.org/onuhabitatmexico/Capacidades-institucionales-ZM-Jalisco.pdf (July 22, 2021).

Hyden, G. (1990) Responses from below: A tale of two Tanzanian villages, *Food Policy*, 15(4), pp. 299-305, https://doi.org/10.1016/0306-9192(90)90071-7.

INAFED (2022) *SiGuia| Resultados GDM 2019-2021* (Mexico: Gobierno de México), available at: http://siglo.inafed.gob.mx/siguia/index.php (November 22, 2022).

INAFED (2022a) *Guía Consultiva de Desempeño Municipal 2022 – 2024 Cuaderno de trabajo*, available at: http://siglo.inafed.gob.mx/siguia/docs/2.%20Cuaderno%20de%20trabajo%20GDM%2022-24.pdf (November 28, 2022).

INAFED (2013) *Resultados Históricos del Programa Agenda Desde lo Local* (Mexico: Gobierno de México), available at: http://www.gob.mx/inafed/acciones-y-programas/resultados-historicos-del-programa-agenda-desde-lo-local (December 4, 2021).

INAFED (2014) *Resultados del Programa Agenda para el Desarrollo Municipal 2014* (Mexico: Gobierno de México), available at: http://www.gob.mx/inafed/acciones-y-programas/resultados-del-programa-agenda-para-el-desarrollo-municipal-2014-66345 (November 22, 2022).

INAFED (2015) *Resultados del Programa Agenda para el Desarrollo Municipal 2015* (Mexico: Gobierno de México), available at: http://www.gob.mx/inafed/documentos/resultados-del-programa-agenda-para-el-desarrollo-municipal-2015-65230 (November 22, 2022).

INAFED (2016) *Resultados del Programa Agenda para el Desarrollo Municipal 2016* (Mexico: Gobierno de México), available at: http://www.gob.mx/inafed/acciones-y-programas/resultados-del-programa-agenda-para-el-desarrollo-municipal-2016 (November 22, 2022).

INAFED (2017a) *INAFED, 15 años fortaleciendo a los Municipios de México. Evolución e historia* (Mexico: Gobierno de México), available at: http://www.gob.mx/inafed/articulos/cual-ha-sido-la-evolucion-del-inafed (November 20, 2022).

INAFED (2017b) *Resultados del Programa Agenda para el Desarrollo Municipal 2017* (Mexico: Gobierno de México), available at: http://www.gob.mx/inafed/documentos/resultados-del-programa-agenda-para-el-desarrollo-municipal-2017 (June 6, 2021).

INAFED (2018) *Resultados del Programa Agenda para el Desarrollo Municipal 2018* (Mexico: Gobierno de México), available at: http://www.gob.mx/inafed/documentos/resultados-del-programa-agenda-para-el-desarrollo-municipal-2018-183273 (June 6, 2021).

INAFED (2022b) *Instituto Nacional para el Federalismo y el Desarrollo Municipal*. (Mexico: Gobierno de México), available at: https://www.gob.mx/inafed (June 6, 2021).

INEGI (2017) *Censo Nacional de Gobiernos Municipales y Delegacionales 2017* (Mexico: CNGDM), available at: https://www.inegi.org.mx/programas/cngmd/2017/default.html#Tabulados (June 6, 2021).

INEGI (2022) *Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2021*, available at: https://www.inegi.org.mx/programas/cngmd/2021/ (December 24, 2022).

INVEDEM (2022) *Antecedentes, ¿Quiénes somos?*, available at: http://www.invedem.gob.mx/invedem/ (November 20, 2022).

Johnson, R. & Kuby, P. (2012) *Estadística elemental* (Mexico: Cengage Learning).

Jonkman, J. (2019) A different kind of formal: Bottom-up state-making in small-scale gold mining regions in Chocó, Colombia, *The Extractive Industries and Society*, 6(4), pp. 1184-1194, https://doi.org/10.1016/j.exis.2019.10.014.

Lagunes-Gómez, I., Hernández-Orduña, M. G., Murrieta-Galindo, R., Hernández-Pitalua, D. & Mayorga-Cruz, D. (2022) Spatial Analysis of the Empirical Behavior of Municipal Institutional Capacity for the Formulation of Sustainable Growth Management Strategies with a Regional Focus: state of Veracruz, Mexico, *Sustainability*, 14(4), https://doi.org/10.3390/su14042000.

Lindbergh, S., Ju, Y., He, Y., Radke, J. & Rakas, J. (2022) Cross-sectoral and multiscalar exposure assessment to advance climate adaptation policy: The case of future coastal flooding of California's airports, *Climate Risk Management*, 38, https://doi.org/10.1016/j.crm.2022.100462.

MacKinnon, D. & Phelps, N. A. (2001) Regional governance and foreign direct investment: The dynamics of institutional change in Wales and North East England, *Geoforum*, 32(2), pp. 255-269, https://doi.org/10.1016/S0016-7185(00)00027-0.

Mahdi, Shivakoti, G. & Inoue, M. (2017) Chapter 16 - Decentralization of Forest Management, Local Institutional Capacity, and Its Effect on Access of Local People to Forest Resources: The Case of West Sumatra, Indonesia, In: Shivakoti, G. P., Pradhan, U. & Helmi (eds.) *Redefining Diversity & Dynamics of Natural Resources Management in Asia*, Volume 1 (India: Elsevier), pp. 305-319, https://doi.org/10.1016/B978-0-12-805454-3.00016-5.

Martínez Tiburcio, M. G. & Cabrera Hernández, A. P. (2018) *Evaluación de la capacidad institucional en la gestión de los municipios mexiquenses de 2011 a 2015 e identificación de alternativas para fortalecerla* (Mexico: Primera Edición), available at: https://ihaem.edomex.gob.mx/sites/ihaem.edomex.gob.mx/files/files/2019/Publicaciones/Evaluacion%20Publicacion%20Electronica%20207_09_17_19.pdf (June 4, 2021).

Marzaniar, P. & Subarsono, A. (2023) Stakeholder salience analysis in the policy formulation of anti-violence against women and children, *Journal of Contemporary Governance and Public Policy*, 4(2), pp. 149-174, https://doi.org/10.46507/jcgpp.v4i2.158.

Mendenhall, W., Beaver, R. J. & Beaver, B. M. (2010) *Introducción a la probabilidad y estadística*, 13a ed. (Mexico: Cengage Learning Editores S.A. de C.V.).

Mitchell, M., Lockwood, M., Moore, S. A. & Clement, S. (2015) Scenario analysis for biodiversity conservation: A social–ecological system approach in the Australian Alps, *Journal of Environmental Management*, 150, pp. 69-80, https://doi.org/10.1016/j.jenvman.2014.11.013.

Montijo Galindo, A. & Ruiz-Luna, A. (2018) El rol de la capacidad institucional como medida de adaptación frente a eventos de precipitación extrema en el noroeste de México, *región y sociedad*, 30(73), https://doi.org/10.22198/rys.2018.73.a985.

Moreno Jaimes, C. (2007) Los límites políticos de la capacidad institucional: Un análisis de los gobiernos municipales en México, *Revista de ciencia política (Santiago)*, 27(2), pp. 131-153, https://doi.org/10.4067/S0718-090X2007000300007.

Moreno Jaimes, C. (2008) Para entender el desarrollo de las capacidades institucionales en los gobiernos municipales en México, *Buen Gobierno*, 5, pp. 49-61.

Nansikombi, H., Fischer, R., Velasco, R. F., Lippe, M., Kalaba, F. K., Kabwe, G. & Günter, S. (2020) Can de facto governance influence deforestation drivers in the Zambian Miombo?, *Forest Policy and Economics*, 120, https://doi.org/10.1016/j.forpol.2020.102309.

Nguyen, V. T. H., McElwee, P., Le, H. T. V., Nghiem, T. & Vu, H. T. D. (2022) The challenges of collective PES: Insights from three community-based models in Vietnam, *Ecosystem Services*, 56, https://doi.org/10.1016/j.ecoser.2022.101438.

Nordberg, K. (2020) Spatial Justice and local capability in rural areas, *Journal of Rural Studies*, 78, pp. 47-58, https://doi.org/10.1016/j.jrurstud.2020.06.008.

Ochoa-Martínez, C. A., Travieso-Bello, A. C., Welsh-Rodríguez, C. M., Conde-Álvarez, C. & Yáñez-Garrido, G. (2016) Gestión de riesgos por eventos extremos de precipitación: El caso de los funcionarios municipales del estado de Veracruz, *Teoría y Praxis*, pp. 94-114.

Orozco Villafañe, A., Huerta Cuervo, R. & López Cruz, J. Y. (2018) Capacidades institucionales de los gobiernos municipales del estado de Oaxaca, In: Estrada, D. La V., Rodríguez, S. y K. & Aurora, C. (eds.) *Condiciones sociales, empobrecimiento y dinámicas regionales de mercados laborales*, Vol. 4 (Mexico: Universidad Nacional Autónoma de México y Asociación Mexicana de Ciencias para el Desarrollo Regional A.C, Coeditores), pp. 305-319, available at: http://ru.iiec.unam.mx/4361/ (August 23, 2020).

Palacios González, F. & Callejón Céspedes, J. (2004) *Técnicas cuantitativas para el análisis regional* (Granada: Editorial Universidad de Granada).

Pedrosa, I., Juarros-Basterretxea, J., Robles-Fernández, A., Basteiro, J. & García-Cueto, E. (2015) Pruebas de bondad de ajuste en distribuciones simétricas, ¿qué estadístico utilizar?, *Universitas Psychologica*, 14(1), https://doi.org/10.11144/Javeriana.upsy14-1.pbad.

Pineda Pablos, N., Moreno Vázquez, J. L. & Díaz Caravantes, R. E. (2019) La capacidad institucional de los consejos de cuenca en México. El caso del Alto Noroeste, 1999-2017, *región y sociedad*, 31, https://doi.org/10.22198/rys2019/31/1029.

PNUD (2022) *IDH Municipal México*, available at: https://www.idhmunicipalmexico.org/ (December 24, 2022).

PNUD (2009) *Desarrollo de capacidades: Texto básico del PNUD*, available at: https://www.undp.org/sites/g/files/zskgke326/files/publications/Capacity_Development_A_UNDP_Primer_Spanish.pdf (November 23, 2022).

PNUD (2019) *Informe de Desarrollo Humano Municipal 2010–2015 Transformando México desde lo local* (Mexico: PNUD), p. 348, available at: http://www.mx.undp.org/content/mexico/es/home/library/poverty/informe-de-desarrollo-humano-municipal-2010-2015--transformando-.html (December 23, 2022).

PNUD (2022) *Sobre nosotros | Programa De Las Naciones Unidas Para El Desarrollo* (UNDP), available at: https://www.undp.org/es/sobre-nosotros (December 23, 2022).

Restrepo, B. L. F. & González, L. J. (2007) De pearson a spearman, *Revista Colombiana de Ciencias Pecuarias*, 20(2), pp. 183-192.

Romo de Vivar Mercadillo, M. R. & Gómez Monge, R. (2016) Descentralización fiscal, capacidades administrativas y recaudación del impuesto predial en los municipios de México: Una aproximación teórica, *Economía y Sociedad*, 20(35), pp. 155-170.

Rosas Huerta, A. (2008) Una ruta metodológica para evaluar la capacidad institucional, *Política y Cultura*, 30, pp. 119-134.

Rosas Huerta, A. (2019) Capacidad institucional: Revisión del concepto y ejes de análisis, *Documentos y Aportes en Administración Pública y Gestión Estatal*, 19(32), https://doi.org/10.14409/daapge.v19i32.8482.

Salas-Martínez, F., Valdés-Rodríguez, O. A., Palacios-Wassenaar, O. M. & Márquez-Grajales, A. (2021) Analysis of the Evolution of Drought through SPI and Its Relationship with the Agricultural Sector in the Central Zone of the state of Veracruz, Mexico, *Agronomy*, 11(11), https://doi.org/10.3390/agronomy11112099.

Salazar Adams, A., Haro Velarde, N. & Loera Burnes, E. (2020) Capacidad institucional de los organismos de agua de Saltillo y Hermosillo, México, *Frontera norte*, 32, https://doi.org/10.33679/rfn.v1i1.1936.

Saldaña, M. R. (2016) Pruebas de bondad de ajuste a una distribución normal, *Revista Enfermería del Trabajo*, 6(3), p. 114.

Schuschny, A. R. & Soto de la Rosa, H. (2009) *Guía metodológica: Diseño de indicadores compuestos de desarrollo sostenible*, available at: https://repositorio.cepal.org/handle/11362/3661 (November 20, 2022).

Segal, E., Feitelson, E., Goulden, S., Razin, E., Rein-Sapir, Y., Kagan, E. J. & Negev, M. (2022) Residential seismic retrofitting: Contextualizing policy packages to local circumstances, *International Journal of Disaster Risk Reduction*, 81, https://doi.org/10.1016/j.ijdrr.2022.103264.

Selva, G. V., Pauli, N., Kim, M. K. & Clifton, J. (2020) Opportunity for change or reinforcing inequality? Power, governance and equity implications of government payments for conservation in Brazil, *Environmental Science & Policy*, 105, pp. 102-112, https://doi.org/10.1016/j.envsci.2020.01.001.

Sidabutar, P., Rukmana, N., Hoff, R. van der & Steinberg, F. (1991) Development of urban management capacities: Training for integrated urban infrastructure development in Indonesia, *Cities*, 8(2), pp. 142-150, https://doi.org/10.1016/0264-2751(91)90007-E.

Singh, M., Griaud, C. & Collins, C. M. (2021) An evaluation of the effectiveness of protected areas in Thailand, *Ecological Indicators*, 125, https://doi.org/10.1016/j.ecolind.2021.107536.

Smucker, T. A., Wisner, B., Mascarenhas, A., Munishi, P., Wangui, E. E., Sinha, G., Weiner, D., Bwenge, C. & Lovell, E. (2015) Differentiated livelihoods, local institutions, and the adaptation imperative: Assessing climate change adaptation policy in Tanzania, *Geoforum*, 59, pp. 39-50, https://doi.org/10.1016/j.geoforum.2014.11.018.

Spiegel, M. R. & Stephens, L. J. (2009) *Estadística* (Mexico: McGraw-Hill).

Tran, T. A. & Rodela, R. (2019) Integrating farmers' adaptive knowledge into flood management and adaptation policies in the Vietnamese Mekong Delta: A social learning perspective, *Global Environmental Change*, 55, pp. 84-96, https://doi.org/10.1016/j.gloenvcha.2019.02.004.

Unda Gutiérrez, M. (2018) Los límites de la recaudación predial en los municipios urbanos de México: Un estudio de casos, *Estudios demográficos y urbanos*, 33(3), pp. 601-637, https://doi.org/10.24201/edu.v33i3.1741.

Valencia Carmona, S. (2016) *El municipio mexicano: Génesis, evolución y perspectivas contemporáneas*, primera edición (Mexico: Secretaría de Gobernación, Secretaría de Cultura, Instituto Nacional de Estudios Históricos de las Revoluciones de México, Universidad Nacional Autónoma de México, Instituto de Investigaciones Jurídicas).

Vilalta, C. (2016) *Análisis de datos*, Primera edición (Mexico: Centro de Investigación y Docencia Económicas).

Vivanco, M. (2005) *Muestreo estadístico. Diseño y aplicaciones* (Chile: Editorial Universitaria).

Volsuuri, E., Owusu-Sekyere, E. & Imoro, A. Z. (2022) Rethinking solid waste governance in Ghana, *Heliyon*, 8(12), https://doi.org/10.1016/j.heliyon.2022.e12235.

Wagner, C. S. & Whetsell, T. A. (2023) *Developing an index of national research capacity*, https://doi.org/10.48550/ARXIV.2306.03981.

Wang, Q., Deutz, P. & Chen, Y. (2017) Building institutional capacity for industrial symbiosis development: A case study of an industrial symbiosis coordination network in China, *Journal of Cleaner Production*, 142, pp. 1571-1582, https://doi.org/10.1016/j.jclepro.2016.11.146.

Appendix:

Table 1: Methodologies for monitoring the MIC

Approach	Agent	Methodologies	Data capture	Period of municipal governance	Municipalities of the RoS with data
Quantitative	Superior Audit of the Federation (ASF)	Municipal Institutional Development Index (IDIM)	2019* 2013**	2018-2021 2011 - 2013	212 212
	United Nations Development Program (UNDP)	Municipal Functional Capacities Index (ICFM)	2016***	2014-2017	212
Mixed (qualitative emphasis)	National Institute for Federalism and Municipal Development (INAFED)	Municipal Performance Consultative Guide (GDM)	Annually, since 2019****	2018-2021	Between 7 and 13
		Municipal Development Agenda Program	Annually, from 2014 to 2018	2014-2017 2018-2021	Between 4 and 29
		Local Agenda Program	Annually, from 2004 to 2013*****	2005-2007 2008-2010 2011 - 2013	Between 0 and 57

Notes: *Published in 2020; **Published in 2015; ** *Published in 2019; ****Effective December 2022, its last update was in 2021, published in 2022; * ****Although the program began in 2004, the municipalities of the RoS began to participate until 2011.
Source: Authors' own elaboration based on ASF (2015, 2022), UNDP (2019), and INAFED (s. f., 2013, 2014, 2015, 2016, 2017b, 2018).

Table 2: Variable Catalog

Variable	Description	Data collection
IDIM	Municipal Institutional Development Index (IDIM)	2019 (ASF, 2022)
ICFM	Municipal Functional Capacities Index (ICFM)	2016 (PNUD, 2019)
PorPob	Percentage of population in poverty	2015 and 2020 (CONEVAL, 2021)
CarProm	Average shortages	2015 and 2020 (CONEVAL, 2021)
IRS	Index of Social Backwardness	2015 and 2020 (CONEVAL, s. f.-b)
CGINI	Gini Index	2015 and 2020 (CONEVAL, s. f.-a)
RdI	Reason for income	2015 and 2020 (CONEVAL, s. f.-a)
IdM	Marginalization index	2015 and 2020 (CONAPO, 2021)
HDI	Human Development Index	2015 and 2020 (PNUD, s. f.)
EI	Education Index	2015 and 2020 (PNUD, s. f.)
II	Income Index	2015 and 2020 (UNDP, s/f)
SI	Health Index	2015 and 2020 (PNUD, s. f.)
SDFRSU	Urban Solid Waste Final Disposal Sites	2016 and 2020 (INEGI, 2017, 2022)
PGRSU	Urban Solid Waste Management Programs	2016 and 2020 (INEGI, 2017, 2022)
PPeO	Potabilization plants in operation	2016 and 2020 (INEGI, 2017, 2022)
PTARMeO	Municipal Wastewater Treatment Plants in Operation	2016 and 2020 (INEGI, 2017, 2022)
PDARMST	Untreated Municipal Wastewater Discharge Points	2016 and 2020 (INEGI, 2017, 2022)
PGAPyS	Programs oriented to the sustainable management of drinking water and sanitation services	2016 and 2020 (INEGI, 2017, 2022)
UPM	Urban planning in the municipality	2016 and 2020 (INEGI, 2017, 2022)

Source: Authors' own elaboration.

Table 3: Adequacy with capacity components defined by Grindle & Hilderbrand (1995)

Dimensions and components	Municipal Performance Consultative Guide (GDM)	Municipal Institutional Development Index (IDIM)	Municipal Functional Capacities Index (ICFM)
The action environment sets:	*2/3*	*1/3*	*2/3*
1. Economic	Yes	No	Yes
2. Political	No	No	No
3. Social	Yes	Yes	Yes
The institutional context:	*5/5*	*3/5*	*3/5*
1. Rules and procedures set for government operations and public officials	Yes	Yes	No
2. The financial resources the government has to carry out its activities	Yes	Yes	Yes
3. The concurrent responsibilities that the government assumes for development initiatives	Yes	No	Yes
4. Structures of formal influence that affect how the public sector functions	Yes	Yes	No
5. Structures of informal influence that affect how the public sector functions	Yes	No	Yes
The task network:	*2/3*	*1/3*	*3/3*
1. Primary organizations	Yes	Yes	Yes
2. Secondary organizations	Yes	No	Yes
3. Supporting organizations	No	No	Yes
Organizations:	*3/4*	*2/4*	*2/4*
1. Structures	Yes	Yes	No
2. Processes	Yes	No	Yes
3. Resources	Yes	Yes	Yes
4. Management styles of organizations	No	No	No
Human resources:	*4/4*	*4/4*	*3/4*
1. Education	Yes	Yes	Yes
2. Attracted to public sector careers and the utilization and retention of individuals as they pursue such careers	Yes	Yes	No
3. Managerial talent	Yes	Yes	Yes
4. Professional and technical talent	Yes	Yes	Yes

Source: Authors' elaboration based on ASF (2022), INAFED, (2022a), and Grindle & Hilderbrand (1995).

Table 4: Conformity assessment of MIC databases with the practical criteria to perform SNR. Unit of analysis: 212 municipalities of the federated state of Veracruz, Mexico

Criteria	Municipal Performance Consultative Guide (GDM)	Municipal Institutional Development Index (IDIM)	Municipal Functional Capacities Index (ICFM)
Maximizes the number of observations	No*	Yes	Yes
Offers contiguous areas across the full territory (complete contiguity)	No*	Yes	Yes
Maximizes comparability with existing studies	No*	Yes	Yes
Maximizes boundary stability over time, facilitating longitudinal studies	Yes	No**	No***
Offers data availability, maximizing opportunities to "scale up" in the future	No****	Yes	Yes

NOTES: * Due to the low participation of municipalities in the programs promoted by INAFED. ** Published in 2015 with data collected in 2013 (period of municipal governance 2010-2013), and in 2022 with data collected in 2019 (period of municipal governance 2018-2021). *** Published in 2019 with data collected in 2016 (period of municipal governance 2014-2017). **** The GDM does not offer a global or integrated indicator but sub-indicators of mixed type (see section 2.4 for more details).

Source: Authors' elaboration based on Harbers & Ingram(2019), INAFED (2022b), ASF (2022), and UNDP (2019).

Table 5: Municipal Institutional Capacity Metrics

Municipal Functional Capacity Index (ICFM)	Municipal Institutional Development Index (IDIM)	
2016	2013	2019
State Average 0.2900	0.4024	0.5124
National average 0.374	0.4383	0.4546

Source: Authors' elaboration based on ASF (2015, 2022) and UNDP (2019).

Table 6: Descriptive Statistics. 212 municipalities of the federated state of Veracruz, Mexico
ICFM 2016 and IDIM 2019, 2013

	ICFM_2016	Std. Error	**IDIM_2019**	Std. Error	**IDIM_2013**	Std. Error
Mean	0.2381116	0.00910605	0.5123953	0.00447095	0.4023547	0.00698088
95% Confidence Lower Bound	0.2201611		0.5035818		0.3885935	
Interval for Mean Upper Bound	0.2560621		0.5212087		0.4161159	
5% Trimmed Mean	0.2312493		0.5148195		0.4069530	
Median	0.2265939		0.5177500		0.4159500	
Variance	0.018		0.004		0.010	
Std. Deviation	0.13258602		0.06509808		0.10164309	
Minimum	0.00000		0.17310		0.07570	
Maximum	0.71126		0.67010		0.63910	
Range	0.71126		0.49700		0.56340	
Interquartile Range	0.16893		0.07252		0.10278	
Skewness	0.695	0.167	-0.982	0.167	-0.827	0.167
Kurtosis	10.097	0.333	30.887	0.333	10.350	0.333

Source: Authors' elaboration based on UNDP (2019) and ASF (2015, 2022). Designed on SPSS.

Table 7: Tests of Normality. Municipalities of the federated state of Veracruz, Mexico. ICFM 2016 and Development Indicators 2015, 2016

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
ICFM_2016	**.062**	**211**	**.045**	**.961**	**211**	**<.001**
PorPob_2015	.059	211	.069	.981	211	.006
CarProm_2015	.069	211	.016	.976	211	.001
IRS_2015	.113	211	<.001	.939	211	<.001
CGINI_2015	.060	211	.064	.985	211	.022
RdI_2015	.029	211	.200*	.994	211	.534
IdM_2015	.063	211	.039	.977	211	.002
IDH_2015	.064	211	.036	.991	211	.218
IE_2015	.068	211	.020	.988	211	.087
II_2015	.064	211	.035	.990	211	.136
IS_2015	.086	211	<.001	.952	211	<.001
SDFRSU_2016	.403	211	<.001	.322	211	<.001
PGRSU_2016	.540	211	<.001	.243	211	<.001
PPeO_2016	.527	211	<.001	.278	211	<.001
PTARMeO_2016	.426	211	<.001	.406	211	<.001
PDARMST_2016	.343	211	<.001	.672	211	<.001
PGAPyS_2016	.504	211	<.001	.454	211	<.001
PUM_2016	.504	211	<.001	.454	211	<.001

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction.

Source: Authors' elaboration based on UNDP (2019, s. f.), CONEVAL (2021, s. f.-a, s. f.-b), CONAPO (2021), and INEGI (2017). Designed on SPSS.

Table 8: Tests of Normality. Municipalities of the federated state of Veracruz, Mexico. IDIM 2019 and Development Indicators 2020

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
IDIM_2019	**.084**	**190**	**.002**	**.942**	**190**	**<.001**
PorPob_2020	.058	190	.200*	.973	190	.001
CarProm_2020	.052	190	.200*	.987	190	.082
IRS_2020	.109	190	<.001	.919	190	<.001
CGINI_2020	.088	190	.001	.923	190	<.001
RdI_2020	.049	190	.200*	.993	190	.550
IdM_2020	.064	190	.059	.973	190	<.001
IDH_2020	.054	190	.200*	.990	190	.196
IE_2020	.063	190	.067	.987	190	.075
II_2020	.047	190	.200*	.992	190	.378
IS_2020	.106	190	<.001	.941	190	<.001
SDFRSU_2020	.386	190	<.001	.676	190	<.001
PGRSU_2020	.541	190	<.001	.200	190	<.001
PPeO_2020	.517	190	<.001	.272	190	<.001
PTARMeO_2020	.353	190	<.001	.435	190	<.001
PDARMST_2020	.217	190	<.001	.829	190	<.001
PGAPyS_2020	.532	190	<.001	.332	190	<.001
PUM_2020	.371	190	<.001	.632	190	<.001

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Source: Authors' own elaboration based on ASF (2022), UNDP (s. f.), CONEVAL (2021, s. f.-a, s. f.-b), CONAPO (2021), and INEGI (2022). Designed on SPSS.

Table 9: Summary of ρ between ICFM 2016, IDIM 2019 and Development Indicators. Municipalities of the federated State of Veracruz, Mexico

	Empirical behavior			**Theoretically expected behavior**			**Hypothesis testing**		
	Spearman's rho (ρ)	Sig. (2-tailed)	N	Null hypothesis	Alternative hypothesis ($H_{1.3}$)	Significance level	Critical values (ρ_c)	Reject the null hypothesis when:	Result of the hypothesis testing
Against									
ICFM_2016:									
PorPob_2015	-0.021	0.757	212						The null hypothesis is confirmed
CarProm_2015	0	0.999	212						The null hypothesis is confirmed
IRS_2015	-0.05	0.469	212						The null hypothesis is confirmed
CGINI_2015	.139*	0.044	212						Alternate hypothesis accepted
RdI_2015	-0.124	0.072	211						The null hypothesis is confirmed
IdM_2015	0.127	0.066	212						The null hypothesis is confirmed
IDH_2015	0.074	0.284	212						The null hypothesis is confirmed
IS_2015	0.043	0.534	212						The null hypothesis is confirmed
II_2015	0.047	0.494	212	$\rho = 0$	$\rho \neq 0$	0.05	0.135	$\lvert \rho \rvert > \rho_c$	The null hypothesis is confirmed
IE_2015	0.101	0.143	212						The null hypothesis is confirmed
SDFRSU_2016	-0.01	0.888	212						The null hypothesis is confirmed
PGRSU_2016	.147*	0.032	212						Alternate hypothesis accepted
PPeO_2016	.281**	<.001	212						Alternate hypothesis accepted
PTARMeO_2016	-0.03	0.665	212						The null hypothesis is confirmed
PDARMST_2016	0.11	0.11	212						The null hypothesis is confirmed
PGAPyS_2016	0.129	0.061	212						The null hypothesis is confirmed
PUM_2016	.159*	0.021	212						Alternate hypothesis accepted
against									
IDIM_2019:									
PorPob_2020	-.441**	<.001	212						Alternate hypothesis accepted
CarProm_2020	-.215**	0.002	212						Alternate hypothesis accepted
IRS_2020	-.460**	<.001	212						Alternate hypothesis accepted
CGINI_2020	.167*	0.015	212						Alternate hypothesis accepted
RdI_2020	-0.043	0.534	212						The null hypothesis is confirmed
IdM_2020	.472**	<.001	212						Alternate hypothesis accepted
IDH_2020	.486**	<.001	212						Alternate hypothesis accepted
IE_2020	.458**	<.001	212						Alternate hypothesis accepted
II_2020	.485**	<.001	212	$\rho = 0$	$\rho \neq 0$	0.05	0.135	$\lvert \rho \rvert > \rho_c$	Alternate hypothesis accepted
IS_2020	.409**	<.001	212						Alternate hypothesis accepted
SDFRSU_2020	0.114	0.097	212						The null hypothesis is confirmed
PGRSU_2020	0.031	0.66	203						The null hypothesis is confirmed
PPeO_2020	.208**	0.002	212						Alternate hypothesis accepted
PTARMeO_2020	.317**	<.001	198						Alternate hypothesis accepted
PDARMST_2020	.183**	0.008	212						Alternate hypothesis accepted
PGAPyS_2020	.137*	0.047	212						Alternate hypothesis accepted
PUM_2020	0.089	0.195	212						The null hypothesis is confirmed

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Authors' elaboration based on Appendix 2a and 2b.

Table 10: Summary of development indicator variables with significant correlation with the 2016 ICFM and the 2019 IDIM. Municipalities of the federated state of Veracruz, Mexico

2016 ICFM against:	
+	Potabilization Plants in Operation 2016 (ρ = 0.281)
	Urban Planning in the Municipality 2016 (ρ = 0.159)
	Urban Solid Waste Management Programs 2016 (ρ = 0.147)
-	Gini coefficient 2015 (ρ = 0.139)
2019 IDIM against:	
+	Human Development Index 2020 (ρ = 0.486)
	Income Index 2020 (ρ = 0.485)
	Marginalization index 2020 (ρ = 0.472)
	Index of Social Backwardness 2020 (ρ = -0.460)
	Education Index 2020 (ρ = 0.458)
	Percentage of population in poverty 2020 (ρ = -0.441)
	Health Index 2020 (ρ = 0.409)
	Municipal Wastewater Treatment Plants in Operation 2020 (ρ = 0.317)
	Average shortages 2020 (ρ = -0.215)
	Potabilization Plants in Operation 2020 (ρ = 0.208)
	Untreated Municipal Wastewater Discharge Points 2020 (ρ = 0.183)
	2020 Gini coefficient (ρ = 0.167)
-	Programs Oriented to the Sustainable Management of Drinking Water and Sanitation Services 2020 (ρ = 0.137)

Source: Authors' own elaboration based on Table 9.