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TOWARDS A MODEL OF THE MANUFACTURE OF TUNISIAN SUBURBAN SPACE: THE CASE OF FOUCHANA

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Abstract: This article analyzes the model of the production of peri-urban space in Fouchana, located in the south of Greater Tunis, by exploring the complexity of the land production system, which integrates various mechanisms of land access and use. To understand this complexity, a systemic approach was adopted, making it possible to take into account the interdependencies between the physical, political, social and economic dimensions of peri-urban land production. In this context, the method of structural equations, in particular the PLS (Partial Least Squares) method, proves to be an appropriate statistical tool. The aim of this method is to examine the existence of causal links between different variables, and to verify the relevance and coherence of a theoretical model. In our case, the latter examines the relationships between the various factors involved in the transformation of land resources dedicated to housing, in particular with regard to the organization of formal and informal land practices.

The results of the study reveal how the processes of land transformation, both formal and informal, influence the social and spatial dynamics of Fouchana. Moreover, they disclose the essential role played by land production in mediating between land mechanisms and urban dynamics, thus revealing the challenges associated with rapid urbanization and growing demographic pressure.

Keywords: urban fabric, land production, formal and informal, systemic modeling, structural equation method.

Introduction

Peri-urbanization in developing countries, particularly in Africa, is characterized by rapid and often disorderly growth of urban peripheries, marked by high land pressure and inadequate land management (Satterthwaite, 2017). This situation results from a formal sector unable to meet the growing demand for housing, which favors the emergence of informal settlements (Guyon, 2019). Thus, urban spaces are composed of a complex coexistence between formal and informal, where official and unofficial mechanisms of access to land intermingle, reflecting the major challenges faced by public authorities in urban planning and regulation (Angel et al., 2012; Lund et al, 2011).

These dynamics are clearly evident in the context of Greater Tunis, which since the 1970s has experienced massive peri-urbanization towards the south, giving rise to several urban nuclei, including the town of Fouchana. Between 1994 and 2004, Fouchana experienced rapid urban growth, establishing itself as a significant urban center. The peri-urban territory is marked by a compartmentalization of land access channels, where spontaneous urbanization and legal urbanization coexist, the latter accounting for almost half of all housing production in Tunis since the 1970s (Barthel, 2006; Binous et al., 1985). According to Durand-Lasserve et al. (2017), the land supply system thus combines two distinct logics: formal and informal.

In this context, we propose to analyze and evaluate a theoretical model focusing on the role of land tenure mechanisms in the structuring of peri-urban space, through a case study of the town of Fouchana. Urban planning appears as a complex system of interdependent elements, where interactions between actors and geographical space shape territorial dynamics (Signoret & Moine, 2008; Houet et al., 2008; Cambien, 2008).

Research question

An in-depth understanding of land dynamics is essential to analyze the urban fabric of Fouchana, a peri-urban area undergoing rapid change. The phenomenon of peri-urbanization is the result of complex land tenure logics, involving public and private, formal and informal actors. Our central question is therefore as follows: **How can land tenure mechanisms explain the urban fabric, both formal and informal, of the town of Fouchana?**

To answer this question, we explore the interactions between land and urban policies, as well as the interplay of actors involved in the production of urban land. The aim is to **understand how these dynamics produce an urbanization that is characteristic of the periphery, marked by the hybridization of land sectors.** We examine the relationships of dependence, complementarity and competition between formal and informal channels, in terms of the practices, spatial forms and social dynamics they generate.

This analysis aims to understand Fouchana's peri-urban factory as a singular territorial production, revealing urbanization patterns specific to metropolitan margins. With this in mind, we mobilize a systemic approach (Bertalanffy, 1968; Antony ,2011), to better account for the complexity, interdependence and self-organization of the urban system. The city is envisaged as a dynamic system where stakeholder strategies, land

constraints and spatial production logics are interwoven, which we seek to model rigorously.

Hypothesis

Our study is based on the idea that the management of peri-urbanization is closely linked to land control, understood as the ability to regulate the rules and practices relating to the various urban soil production sectors. Three hypotheses structure our thinking. **The first concerns land tenure mechanisms**: the transformation of usage rights, the diversity of land tenure systems and state intervention in regulation, prices and partnerships directly influence the production of peri-urban space in Fouchana.

The second is the intertwining of formal and informal channels, whose practices tend to converge. Actors combine official norms and informal strategies, blurring the boundaries between legality and illegality in terms of access to land and urban production methods.

Finally, **the third hypothesis assumes that the urban fabric of Fouchana is the result of a complex dynamic, arising from the interaction between social and spatial logics specific to these sectors.** The strong demand for land, often driven by an external population, fuels urbanization marked by residential mobility, housing standardization and rapid transformation of the urban fabric. This complexity leads us to consider a systemic model of the phenomenon.

Literature review

Land mechanisms

Land mechanisms refer to the coordination arrangements that govern land use and enable property rights to be modified (Messina, 2019). Halleux et al. (2012) propose a model based on the links between cost, regulation and collaboration, structuring land use around four elements: coordination, dependency between actors, governance organization and conflict resolution rules.

Land production

Land production refers to all the stages by which a plot of land becomes accessible to purchasers, via a gradual structuring of rights, and then placement on the formal or informal land market. It generates a wide variety of forms of tenure (Durand-Lasserve et al., 2017).

Notion of formal/informal

Clarifying the distinction between formal and informal is essential to analyzing urbanization in Fouchana. The "formal", derived from economics, refers to employment or practices framed by official norms (Bennafla, 2015), while the "informal" designates what

escapes legality, notably in terms of construction or land use. However, this binary opposition has been called into question: formal and informal land practices, actors and channels intertwine, cooperate or overlap, blurring their distinction.

The urban fabric, in the context of the complex dynamics of the city as a system, can be defined as a social, spatial and temporal process by which the urban fabric is continuously and dynamically transformed (Noizet, 2007). This process results from the dialectical interaction between urban society (its actors, practices, representations and social temporalities) and the materiality of the city (its spatial organization, morphology, built forms and road network) (Houet et al, 2008). The urban fabric thus integrates the complexity of multiple decisions, negotiations and appropriations of urban spaces by diverse actors (inhabitants, political and economic powers, developers), in a context marked by long temporalities and non-linear transformations.

Methodology

In order to test our theoretical model, which seeks to identify the modalities of the urban fabric of the town of Fouchana, based on the land tenure mechanisms that govern the formal and informal sectors, we resort to a systemic approach to the peri-urban fabric. This approach aims to make it easier to understand a complex phenomenon by examining its internal dynamics. To implement this approach, we chose the structural equation method (SEM), based on covariance, which enables the researcher to simultaneously model and estimate complex relationships between variables (Hair et al, 2022). We chose the latter because it can confirm or reject a theoretical model composed of a set of systemic relationships between several variables. In other words, our theoretical model is made up of concepts and causal relationships between them, broken down into hypotheses, which question the links between the various theoretical variables. From a more practical perspective, the systemic approach adopts a hypothetico-deductive approach in which hypotheses are formulated and then confronted with empirical facts (Morlaix, 2002).

We begin with a theoretical exploration of the model, defining latent variables based on existing literature, then develop measurement scales integrating manifest variables and questionnaire items. We also analyze the survey results, examining response rates and frequencies.

Results are presented from a systemic analysis performed with the Path Modeling PLS method, where we assess the reliability and validity of latent variables. This includes examining our measurement model to check whether the latent variables converge on their associated concepts. Finally, we validate the structural model by testing hypothetical relationships between endogenous and exogenous latent variables, to confirm whether these relationships are supported by empirical data and to assess the model's predictive capacity.

I The theoretical design of the model

1. Model description

A theoretical model, an abstract representation of entities and their relationships (Trinchera & Esposito-Vinzi, 2006), is used to analyze the peri-urbanization of Fouchana, integrating formal and informal land tenure mechanisms in the face of rapid urbanization and demographic pressure. This model aims to understand how these processes influence the peri-urban structure by crossing political, economic and social dimensions.

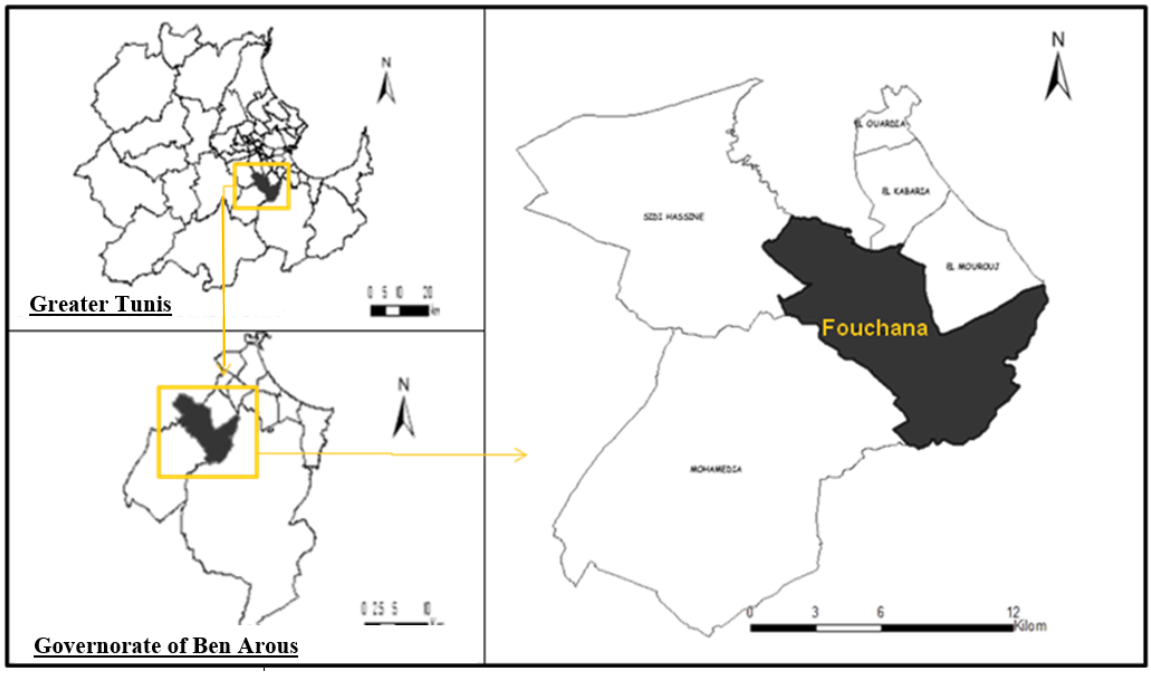
Located to the south of Greater Tunis, close to major infrastructures such as the RN3, Fouchana constitutes the third urbanization ring of the Ben Arous governorate. Created in 2016 as part of the decentralization process, it comprises four sectors: Fouchana, El Hidhab, El Mostakbel and El Mghira (Ben Jelloul, 2017). Its demographic growth, strong between 2004 and 2014 and then stabilized, is explained by industrial development, employment opportunities and favorable topography, with a positive migratory balance.

The political context has encouraged this spatial expansion through a liberal land policy, notably the privatization of land formerly managed by the OMVVM[1] and the abolition of state land reserves, thus freeing up the land market and anticipating urbanization. However, urban policy faces major challenges: despite several urban planning documents, their implementation remains inconsistent and insufficient. The Fouchana urban development plan reveals a discrepancy between the intended use of land and its actual use, which limits the effectiveness of territorial planning in the face of diffuse and fragmented urbanization.

Since 1994, the city of Fouchana has experienced an urban boom. Urbanization trends continue to rise, confirming the city's peri-urban character and reflecting a synchronized development of both formal and informal land production along its two main road axes. As a result, a complex coexistence has emerged within the same neighborhoods, where regulated land and real estate developments exist side by side with informal subdivisions intended for housing. The boundaries between these two facets appear blurred, sometimes interwoven, illustrating the phenomenon of hybridity between formal and informal sectors in the urban fabric of Fouchana.

[1] OMVVM Office for the Development of the Medjerda Valley, was a Tunisian public organization responsible for the management, development and agricultural supervision of the Medjerda Valley, a key region for Tunisian agriculture. Created between 1950 and 1970, it was responsible for managing irrigated perimeters, hydro-agricultural infrastructures and coordinating agricultural development actions in the area.

Figure1 . Geographical location of the town of Fouchana



Source: Zemzeme, 2024

In light of this hybrid and fragmented urban reality, marked by multiple interactions between regulatory frameworks and informal practices, it becomes essential to adopt a structured theoretical framework to analyze the underlying logics. A conceptual model thus provides a means to formalize these complex dynamics and to identify the variables that influence the peri-urban fabric of Fouchana. From this perspective, our model adopts a reflective structure of a complex nature, as it explores several interrelated conceptual levels. First-order concepts are evaluated using reflective indicators**.**

The model consists of three main elements**:**

Land tenure mechanisms are the latent exogenous explanatory variable, comprising three dimensions: political, economic and social. These dimensions have a structuring and explanatory impact on modes of land production, both formal and informal.

Land production: this is a mediating variable between the latent exogenous variable and the latent endogenous variable. It comprises three concepts: spatial characteristics of land production, practices related to formal land production and practices related to informal land production.

The urban fabric: the endogenous latent variable that should be explained by land tenure mechanisms and their impact on the land production process. It is made up of two concepts: social and spatial characteristics. The research hypotheses define the relationship between the latent variables as follows:

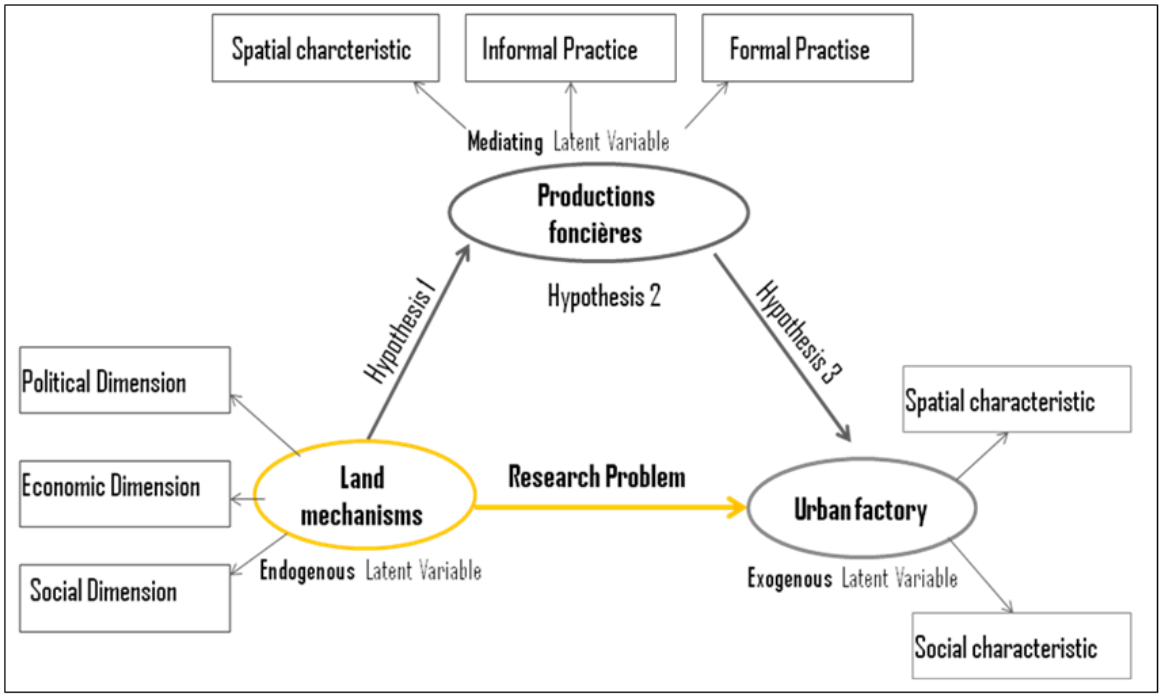
H1; A first hypothesis is linked to the question of land tenure mechanisms: the ways in which land use law changes are responsible for the creation of the peri-urban space of the town of Fouchana.

H2; A second hypothesis assumes that the generation of formal and informal land production is a manifestation of the ways in which land use rights change.

H3; The third hypothesis is linked to the urban fabric of the town of Fouchana, which corresponds to a complex urban model, the result of the interrelation between social and spatial relationships, resulting from the tangle of formal and informal production.

The evaluation of our constructs should be ensured by the measures collected through quantitative methods, constituted by the items.

Figure2 . Global model and auxiliary theories of the urban fabric in Fouchana



Source:Zemzeme, 2024

2. Data collection mode

2.1 **Questionnaire presentation**

Our survey is based on fieldwork aimed at understanding the process of land transformation in Fouchana and the actors involved. The decision to focus on residents as primary actors stems from their central and multifaceted role: they participate both as buyers and sellers, in both formal and informal land markets, and this applies to raw land as well as serviced plots.

Unlike other stakeholders (elected officials, developers, institutions), residents are directly affected by land dynamics, which they help shape through their practices, buying,

reselling, building, or bypassing regulations. Their involvement reveals the social, economic, and territorial logics at work in the urban production process.

Moreover, their local anchoring and socio-professional diversity make them valuable sources for accessing detailed data: acquisition channels, support networks, location strategies, as well as perceptions of land prices and constraints. In this regard, residents serve as key indicators of contemporary land mechanisms, particularly in contexts marked by fragmented governance.

Furthermore, the questionnaire includes a first section documenting the demographic profile of respondents, while the second section explores latent variables, enabling a precise quantitative analysis of our conceptual model, in accordance with the methodological principles established by Fowler (2014) and Bryman (2016).

2.1.1 ***The independent variable: land tenure mechanisms***

The mechanisms for coordinating land resources can be summed up as price, settlement and partnership in the various land tenure systems (Messina, 2019). This refers to the three main dimensions responsible for the transformation of land from agricultural to urban use, namely the political, economic and social dimensions (Halleux et al 2012). For the political dimension, the aim is to highlight the different modalities recommended by land policies to effectively manage the land resource and make it available for territorial development projects.

The economic dimension of access to land is reflected in the functioning of the land market, influenced by the laws of supply and demand, which govern the dynamics of land prices. As for the social dimension, it manifests itself through social configurations involving a multitude of actors who influence changes in land use through various strategies and actions(Pellegrino, 2005).

2.1.2 ***The latent mediator variable; Land production***

Land production encompasses land transformation processes, including the formalization of land rights, marketing and infrastructure works. It acts as an intermediary between land tenure mechanisms and peri-urban dynamics, acting as a barometer of compliance with transformation processes (Halleux, 2005; Durand-Lasserve et al, 2017). Often, formal activities drift towards the informal, bypassing certain rules and creating a convergence between formal and informal land production modalities (Chabbi, 2005; Gérard & Boughdir, 2012). This latent variable is made up of three constructs: the spatial characteristics of land production channels, practices in formal channels and those in informal channels.

2.1.3 ***The dependent variable; The urban factory***

Our research examines the dynamics of peri-urban urbanization, focusing on the land mechanisms that underpin it (AUGT, 2002; Chauveau, 1997; Halleux, 2015; Legros, 2019; Elloumi, 2011). The main endogenous variable, which we analyze, results from the

complex interaction between land production processes, whether formal or informal, and is influenced by geographical features and social dynamics present in peri-urban areas.

2.2 **Empirical test**

2.2.1 ***Sampling method and sample size***

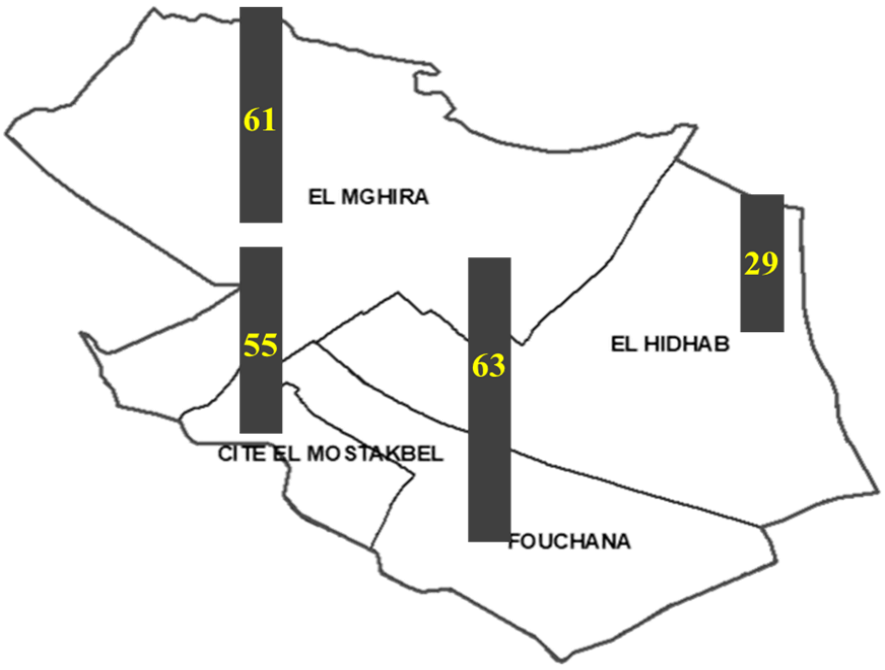
Our research focuses on the dynamics of peri-urban urbanization, examining the land tenure mechanisms that underpin it. We developed a theoretical model and identified indicators to measure our latent variables, then proceeded to an empirical phase to assess the validity and reliability of our measurement scales. Given that the fundamental objective of this survey is to obtain answers to our questions from the various categories of the population in the four sectors, we used a systemic random sampling approach (Haon, 2008).

This is a non-probabilistic method used to avoid random sampling. This method offers greater representativeness, since there is a greater chance of independence.

The recommendations of Hair et al (1998) were of key importance in determining the sample size for our research. They stressed that a sample should comprise a number of cases interviewed at least ten times greater than the number of items (or questions) in the largest scale used.

In our case, the largest scale of our questionnaire consists of 16 questions. To avoid the impact of non-response bias on the expected sample size of 160. We have broadened the spectrum of the survey population. As a result, the sample size to be surveyed is 220 people, with 208 responses.

Figure3 . Number of responses in the different sectors of the city of Fouchana



Source:Zemzeme, 2024

II Measurement model analysis

For the analysis of our model, we used SmartPLS 4 (2023 version), a structural equation modeling software based on the Partial Least Squares method (PLS-SEM). Particularly well-suited for small samples, it does not require data normality, unlike covariance-based methods. It follows the “10-times rule” to determine the minimum sample size (Hair et al., 2022; Malik, 2020).
Thanks to its flexibility and strong predictive capabilities, SmartPLS is widely used in contexts where data is limited or imperfect, particularly in social sciences and management (Sarstedt & Cheah, 2019). It is known for its intuitive graphical interface, allowing users to build models via drag-and-drop without the need for programming. Although not entirely free, a trial version and free student licenses are available. The software also offers built-in documentation and export functions that facilitate the analysis and interpretation of results (Kock & Hadaya, 2018).

So, we start with the measurement model analysis, which is made up of:

- Analysis of constructreliability
- Convergent validityanalysis
- Discriminant validityanalysis

1. Testing construct reliability and scale purification

Assessing the reliability of the constructs in a Smart-PLS model is essential to guarantee the quality of the variables used. This involves examining the external loadings, or "loadings", eliminating those below 0.6, to ensure that the items actually measure the same concept. Two main reliability tests are performed: Cronbach's Alpha and the Composite Reliability Index, both of which must exceed 0.7 to be considered reliable. These analyses confirm the internal consistency of the constructs and ensure that the measures used in the model are robust and reliable (Jôreskog, 1970; Wiley et al, 2012).

1.1 **Testing the reliability of the scale relative to the exogenous variable: land tenure mechanisms**

Analysis of the reliability of manifest variables in land tenure mechanisms in Fouchana reveals three key dimensions: political, economic and social. The political dimension, with loadings above 0.6, shows that land policy is influenced by land privatization and support for informal value chains, while the economic dimension, reduced to 2 items with loadings > 0.8 and an Alpha of 0.747, highlights rising land prices and increased recourse to bank loans. Finally, the social dimension, with two items showing high loadings (0.8), indicates that access to land motivates migration to Fouchana, all supported by reliability coefficients above 0.7.

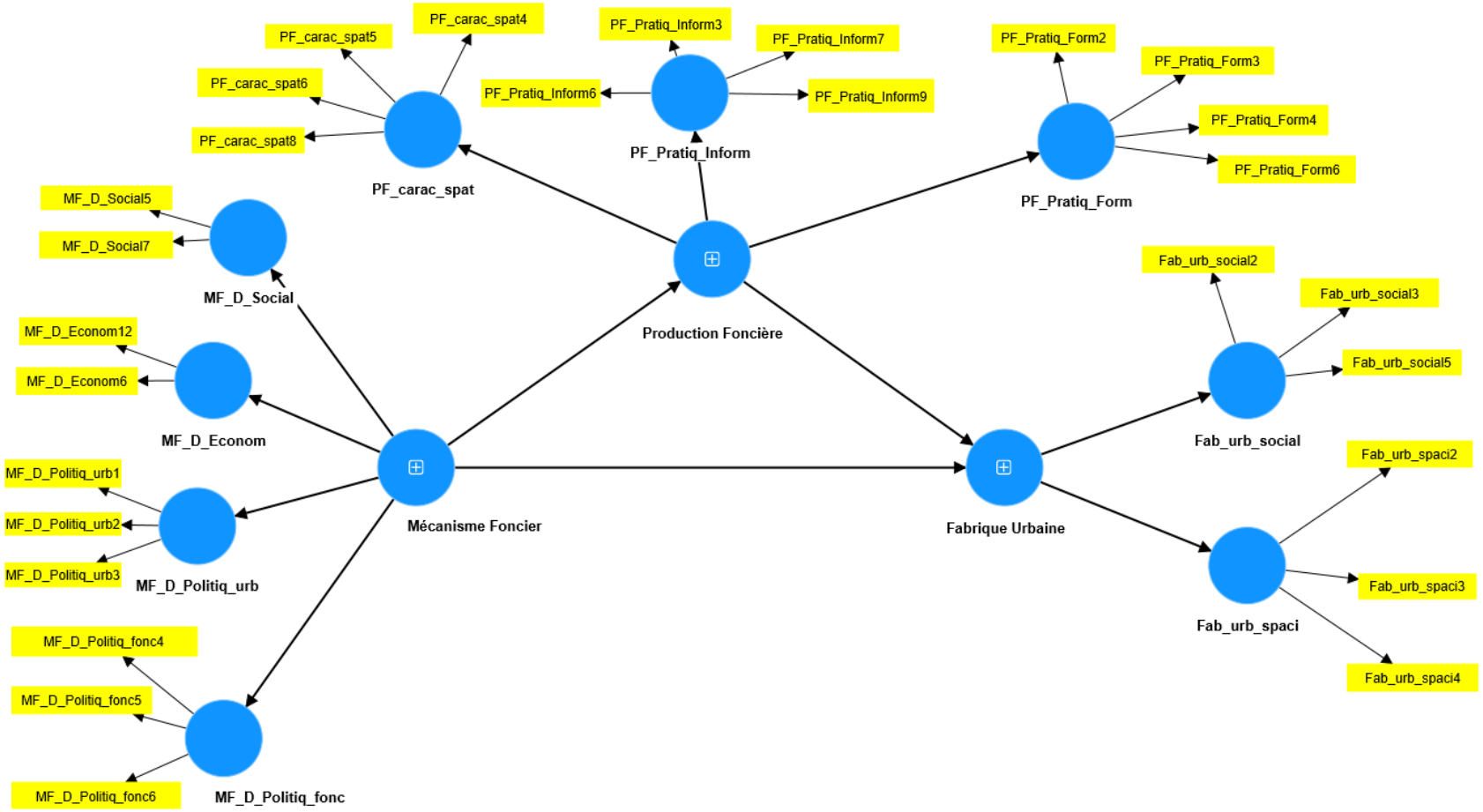
1.2 **Testing the reliability of the mediator variable: land production**

The assessment of land tenure mechanisms in Fouchana highlights the complexity of interactions between formal and informal dimensions in a context of rapid peri-urbanization. Since the 1970s, the town has evolved from an agricultural base to intense urbanization, resulting in land fragmentation and pressure on housing. Four items were used to measure the spatial characteristics of land production, all with high reliability indices (Cronbach's Alpha > 0.8). Formal channels reveal practices such as speculation, while informal channels highlight corruption, with an Alpha of 0.798. These results reinforce the methodological validity and show how these mechanisms influence urban organization in Fouchana.

1.3 **Testing the reliability of the endogenous variable: the urban fabric of the city of Fouchana**

Analysis of the social and spatial characteristics of the urban fabric in Fouchana shows good internal consistency between constructs. Over 70% of the variation in social indicators is explained by the construct, highlighting positive net migration and socio-professional diversity. Cronbach's Alpha indices are satisfactory, confirming the validity of the scale, while spatial characteristics show a high correlation (above 0.7) with an Alpha of 0.764. These results reinforce the methodological robustness and validity of the conclusions.

Figure4 . The global model of the urban factory



Source: Own formulation based on Out Put from Smart PLS 4 software, 2024

2. Convergent validity test

Validity refers to the ability of indicators to accurately measure a construct, while convergent validity is achieved when more than 50% of the variance of a latent variable is shared with its measures rather than measurement error (El Ouidani& El Fakir, 2017). To assess this validity, it is crucial that indicators are consistent and well correlated, effectively capturing the same concept (Gana & Broc, 2018). Good convergent validity ensures that measures accurately reflect aspects of the construct under study. This assessment is essential to ensure the reliability of the instruments used in the model.

Assessment of the convergent validity of land tenure mechanisms in Fouchana shows that all constructs meet the criteria of Fornell & Larcker (1981), with the political dimension sharing over 60% of its variance with its measures, while the social and economic dimensions display over 70% of shared variance. For the moderator variable of land production, the average variance index (AVE) indicates that the items converge effectively, sharing over 50% of their variance with their own items. For the endogenous variable, the two constructs also show a consistent AVE, sharing over 60% of their variance with their respective items, thus confirming the validity of the measures and the robustness of the model.

3. Discriminant validity test

Discriminant validity is essential for validating a model, as it assesses whether each construct is distinct from the others (Balambo& El Baz, 2014). This is done in two stages: first, by examining item cross-correlations to ensure that an item has a higher correlation with its associated construct than with other constructs. Next, the Fornell-Larcker criterion is applied, comparing the square root of the average variance extracted (AVE) of each construct with its correlations with the other constructs. Satisfactory discriminant validity is achieved when the square root of the AVE exceeds the correlations with other variables, ensuring that each construct accurately and distinctly measures the concept it represents (Tritah& Daoud, 2022).

The results in the table below show that the discriminant validity of the different constructs is well verified through its strong correlation with its items, as with the other constructs. This correlation is highlighted by the high values of the cross-loadings, which indicate a strong association between the items and their respective constructs (Gana, & Broc, 2018). This observation suggests that the different constructs of the model, namely the dimensions of land mechanisms, land production and the socio-spatial characteristics of the urban factory effectively capture the items they are supposed to represent, and that they are distinct from the other constructs of the model.

Table1 . Cross loadings results of the different constructs of the model

Built	***AV*E**
Land mechanisms	
Political dimension (Land policy)	**0,630**
Political dimension (Urban policy)	**0,680**
Economic dimension	**0,798**
Social dimension	**0.728**
Land production channels	
Spatial features	**0,636**
Practices in formal channels	**0,598**
Practices in informal channels	**0,622**
Urban Factory	
Social features	**0,630**
Spatial features	**0,680**

Source: Own elaboration based on Out Put from Smart PLS 4 software, 2023

3.1 **Fornell-Larcker test for different variables**

The Fornell-Larcker criterion assesses discriminant validity by comparing the square root of the average variance extracted (AVE) of each construct with its correlations with the other constructs (Hair et al, 2022). For a construct to be considered as having discriminant validity, its AVE square root must be greater than these correlations, ensuring that each construct measures unique dimensions (Bennaceur & Chafik, 2019). In our analysis, we found that each construct's AVE square root is higher than its correlations with the other constructs, indicating satisfactory discriminant validity. The off-diagonal elements in our correlation matrix are lower than the AVE square root values, confirming that the constructs are well differentiated from each other.

Table2 . Results of the discriminant validity test discriminant through the Fornell-Larcker criterion

	Fab_urb social	Fab_urb _spaci	MF_D Economy	MF_D_ Politiq_fonc	MF_D_ Politiq_urb	MF_D Social	PF_Pratiq Form	PF_Pratiq _Inform	PF_carac _spat
	Fab_urb social	**Fab_urb _spaci**	**MF_D Economy**	**MF_D_ Politiq_fonc**	**MF_D_ Politiq_urb**	**MF_D Social**	**PF_Pratiq Form**	**PF_Pratiq _Inform**	**PF_carac _spat**
Fab_urb_social	**0,794**								
Fab_urb_spaci	0,160	**0,825**							
MF_D_Econom	0,203	0,448	**0,893**						
MF_D_Politiq_fonc	0,100	0,160	0,204	**0,794**					
MF_D_Politiq_urb	0,160	0,800	0,848	0,160	**0,925**				
MF_D_Social	0,134	0,120	0,126	0,134	0,120	**0,887**			
PF_Pratiq_Form	0,241	0,286	0,257	0,241	0,286	0,264	**0,774**		
PF_Pratiq_Inform	0,150	0,781	0,834	0,151	0,901	0,112	0,271	**0,989**	
PF_carac_spat	0,164	0,200	0,211	0,164	0,200	0,847	0,334	0,197	**0,797**

Source: Own formulation based on Out Put from Smart PLS 4 software, 2023

III Structure model analysis

The structure model establishes links between endogenous variables and other latent variables, with an internal analysis assessing the predictive relevance of latent variables, also known as nomological validity (Fernandes, 2012).

To evaluate the structure model, two indicators are examined. These include the R^2 coefficient of determination and the Stong-Geisser Q^2 coefficient.

1. Coefficient of determination test R^2

The coefficient of determination R^2 assesses the validity of the structural model by measuring the variance explained for an endogenous variable by the exogenous variables (Hair et al., 2017). According to Croutsche (2002), an R^2 between 0 and 1 indicates a significant model, between 0.05 and 0.1 a highly significant model, and below 0.05 an

insignificant model. In our model for Fouchana, the endogenous variable of land production is influenced by the organization of production, which comprises two constructs: social and spatial characteristics. The moderator variable is made up of three constructs linked to the characteristics and practices of formal and informal value chains.

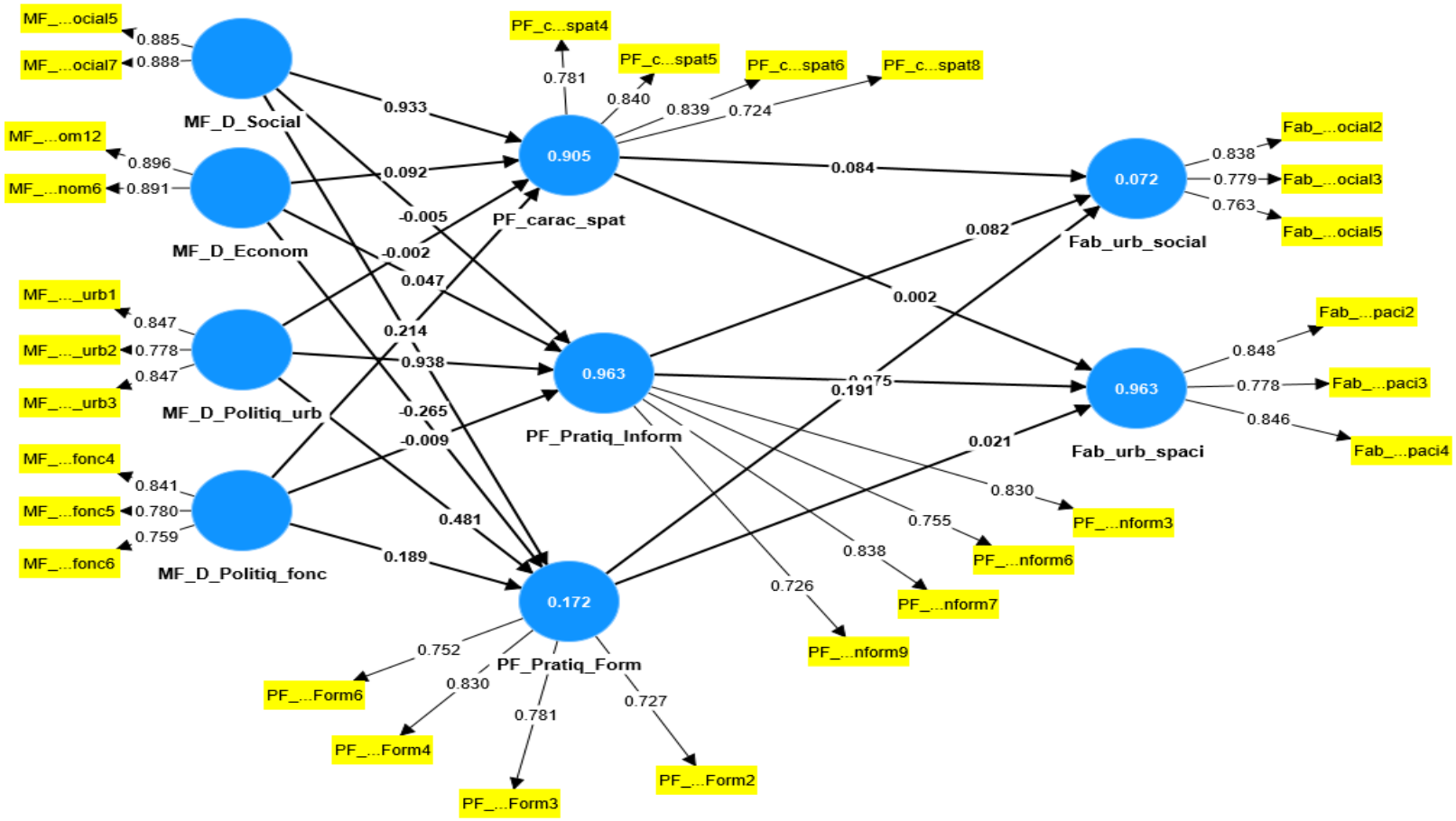
Table3 . Result of the coefficient of determination of R-square (R^2)

	R-square	R-square adjusted
Fab_urb_social	0,072	0,058
Fab_urb_spaci	0,963	0,962
PF_Pratiq_Form	0,172	0,155
PF_Pratiq_Inform	0,963	0,962
PF_carac_spat	0,905	0,903

Source: Own elaboration based on Out Put from Smart PLS 4 software, 2023

The R^2 values indicate that most of the variance in the urban spatial factory is explained by land tenure mechanisms (96%), although the latter have no significant predictive power on social characteristics. On the other hand, over 90% of the variance in land production is also explained by these mechanisms, showing strong predictive power for spatial characteristics and practices in informal channels, but less so for those in formal channels.

Figure5 . The structural model fitted according to the R-square coefficient of determination (R^2)



Source: Own elaboration based on Out Put from Smart PLS 4 software, 2023

2. f² coefficient test

The effect size index is crucial for assessing the validity of the structural model, as it indicates the impact of exogenous variables with a moderating effect on endogenous variables (Bennaceur and Chafik, 2020). This index measures the cross-validity between the observable variables of an endogenous variable and those associated with latent variables. Values of 0.02, 0.15 and 0.35 correspond respectively to weak, medium or strong effects. In our model, we first assessed the impact of land tenure mechanisms on land production, then their effect on the Fouchana peri-urban factory.

Table4 . Result of the F² size index matrix

	Fab_urb_social	**Fab_urb_spaci**	**MF_D_Econ**	MF_D_Politiq_fonc	MF_D_Politiq_urb	MF_D_Socia	**PF_Prati_Form**	**PF_Prati_Inform**	**PF_cara_spat**
Fab_urb_social									
Fab_urb_spaci									
MF_D_Econom							**1,008**	**1,006**	**1,009**
MF_D_Politiq_fonc							**1,040**	**1,002**	**1,004**
MF_D_Politiq_urb							**1,028**	**2,355**	**1,000**
MF_D_Social							**1,054**	**1,001**	**8,901**
PF_Pratiq_Form	**1,033**	**1,010**							
PF_Pratiq_Inform	**1,007**	**23,227**							
PF_carac_spat	**1,007**	**1,000**							

Source: Own formulation based on Out Put from Smart PLS 4 software, 2023

This analysis process enables us to understand the influence of the various model variables on the conceptual constructs, and to assess their contribution to understanding the phenomenon under study.

The effect size index is crucial for assessing the impact of variables in a model, measuring the strength of the relationship between them. It determines whether variations in f² values are significant, with thresholds defining weak, medium or strong effects (0.02, 0.15 and 0.35 respectively). In our analysis, the f² values for land production show a satisfactory

explanatory power for land mechanisms, while the impact on the urban fabric varies significantly. These results confirm the validity of the model and underline the importance of land tenure mechanisms in urban dynamics.

3. Testing the hypothesesformulated

The hypothesis-testing process evaluates the relevance of path coefficients between latent variables using the bootstrapping method on a sample of 200 respondents, in accordance with Chin (1998). Two main criteria are used: Student's T coefficient, which indicates the significant impact of the explanatory variables (with a threshold of 1.96), and the P-value, which must be less than 0.05 to validate a relationship. These criteria are used to assess the validity and reliability of the relationships in the model.

3.1 **Test of the first hypothesis; Land mechanisms/urban fabric of the city of Fouchana**

Our first hypothesis examines the direct effect of land tenure mechanisms on the peri-urban fabric of Fouchana. The results show that the economic dimension has no significant impact on the spatial and social fabric, with Student's T coefficients of 0.74 and 0.9, and P-values greater than 0.05. Similarly, the relationship between land policy and urban production is also unsatisfactory, with very low coefficients (0.033 and 0.012) indicating a lack of significant correlation. Urban policy, on the other hand, shows a positive relationship with urban production. Finally, social mechanisms also have no direct effect on the social and spatial fabric, as the correlation indices do not respect the tolerated limits. These results underline the complexity of the interactions between these dimensions in Fouchana.

We conclude that our first hypothesis is not confirmed, and that land tenure mechanisms with their three dimensions do not have a direct effect on the urban fabric.

3.2 **Testing the second hypothesis; Land mechanisms / land production**

Our second hypothesis postulates that land tenure mechanisms influence the entanglement of land production. The results show a significant correlation between the economic dimension of land tenure mechanisms and land production, with Student's T coefficients of 1.78 and 84, and satisfactory P-values (Table 5). However, the effect on practices in informal channels was not significant. For the political dimension, the impact of land policies is significant, except for informal practices. Urban policy also has a positive effect on land production. Finally, social mechanisms show a satisfactory correlation with spatial characteristics and practices in informal channels. These results underline the complexity of economic and political dynamics in Fouchana.

Table6 . Result of the test of the second hypothesis

Built	Original sample (O)	Sampleme an (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Economic dimension of land mechanisms / land production					
MF_D_Econom ->PF_Pratiq_Form	0.178	0.183	0.095	**1.782**	**0.086**
MF_D_Econom ->PF_Pratiq_Inform	0.047	0.047	0.049	0.966	0.334
MF_D_Econom ->PF_carac_spat	0,935	0,936	0,011	**84,165**	**0,000**
Political dimension of land mechanisms / land production					
MF_D_Politiq_fonc ->PF_Pratiq_Form	0.189	0.198	0.076	**2.472**	**0.013**
MF_D_Politiq_fonc ->PF_Pratiq_Inform	-0.009	-0.008	0.013	0.661	0.509
MF_D_Politiq_fonc ->PF_carac_spat	0,166	0,169	0,079	**2,111**	**0,035**
MF_D_Politiq_urb ->PF_Pratiq_Form	0.481	0.485	0.196	**2.461**	**0.014**
MF_D_Politiq_urb ->PF_Pratiq_Inform	0.938	0.938	0.046	**20.511**	**0.000**
MF_D_Politiq_urb ->PF_carac_spat	-0.002	-0.003	0.077	0.027	0.978
Social dimension of land mechanisms / land production					
MF_D_Social ->PF_Pratiq_Form	0.214	0.215	0.082	**2.614**	**0.009**
MF_D_Social ->PF_Pratiq_Inform	-0.005	-0.005	0.013	0.378	0.705
MF_D_Social ->PF_carac_spat	0.933	0.932	0.014	**67.078**	**0.000**

Source: Own formulation based on Out Put from Smart PLS 4 software, 2023

We deduce, therefore, that the hypothesis of the relationship between land tenure mechanisms and the organization of formal and informal land production channels is well confirmed, and that the first mediation effect is well proven.

3.3 **Test of the third hypothesis; Land production/urban fabric of the city of Fouchana**

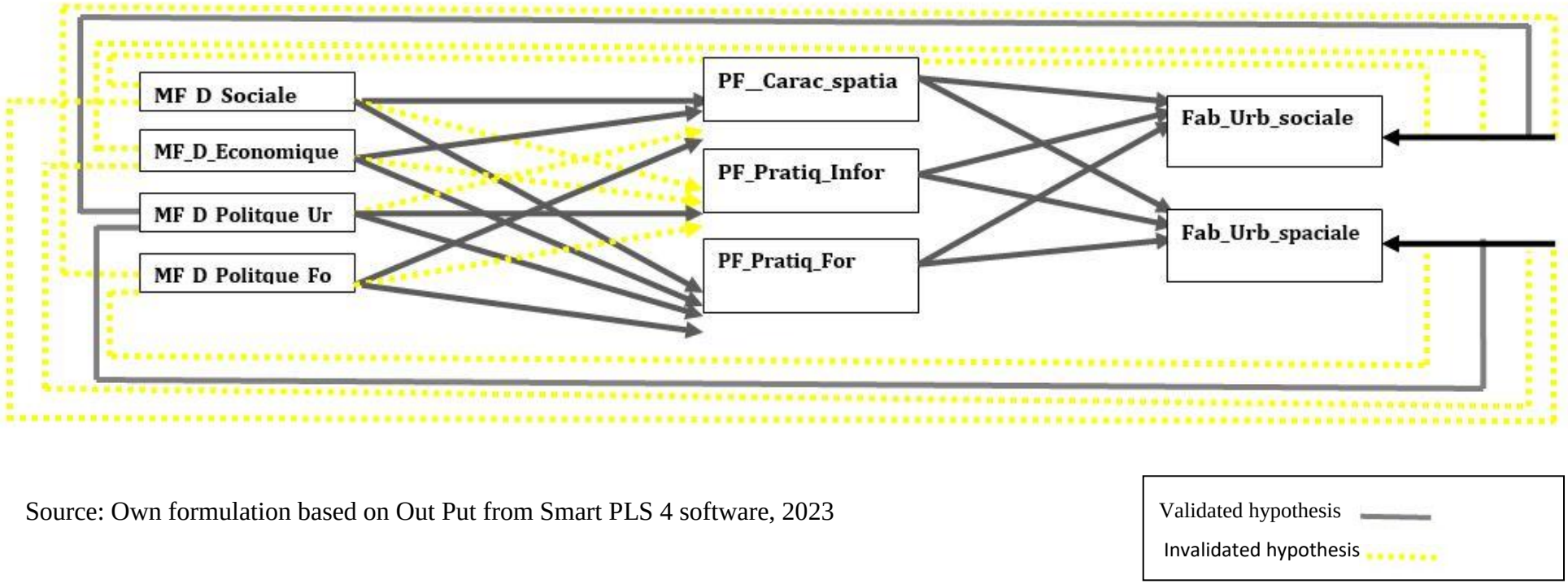
The third hypothesis examines the impact of formal and informal land production on the peri-urban fabric of Fouchana. The results show a significant influence of these productions on the peri-urban factory, both spatially and socially, with Student's T coefficients varying between 2 and 190 and P-values below 5% (Table 7). This validates our hypothesis and confirms the second mediation effect. In addition, there is a statistically significant influence of the mediating variable on the land and urban fabric mechanisms, reinforcing the relevance of our model to explain land and urban dynamics in the region.

Table8 . Results of the test of the third hypothesis

Built	**Original sample (O)**	**Samplem ean (M)**	**Standard deviation (STDEV)**	**T statistics (|O/STDEV|)**	**P values**
Practices in the formal sector/peri-urban factory in the town of Fouchana					
PF_Pratiq_Form ->Fab_urb_social	0.191	0.202	0.092	**2.068**	**0.039**
PF_Pratiq_Form ->Fab_urb_spaci	0.933	0.932	0.014	**67.078**	**0.000**
Practices in the informal sector / peri-urban factory in the town of Fouchana					
PF_Pratiq_Inform ->Fab_urb_social	0.189	0.198	0.079	**2.472**	**0.019**
PF_Pratiq_Inform ->Fab_urb_spaci	0.975	0.975	0.005	**190.609**	**0.000**
Characteristics of land production / *peri-urban* factory *in the town of Fouchana*					
PF_carac_spat ->Fab_urb_social	0.168	0.173	0.090	**1.772**	**0.070**
PF_carac_spat ->Fab_urb_spaci	0.933	0.932	0.014	**67.078**	**0.000**

Source: Own formulation based on Out Put from Smart PLS 4 software, 2023

Figure6 . Results of confirmed and rejected hypotheses



Source: Own formulation based on Out Put from Smart PLS 4 software, 2023

4. Discussion of results

After testing land tenure mechanisms in Fouchana, we obtained significant results. The first hypothesis, linking land tenure mechanisms to the peri-urban fabric, is rejected, indicating the absence of a direct impact of factors of access to the land resource. This suggests that other variables or mechanisms may play a more predominant role in shaping the urban fabric of the city.

On the other hand, the second hypothesis is confirmed: the economic dimension of land mechanisms influences the urban landscape, notably through the land market and the policies that regulate these practices. The complexity of the dynamics between formal and informal sectors is highlighted, with increasing pressure on agricultural land due to rapid urbanization (Mélé, 2009). In addition, urban policies, through various planning instruments, are often out of step with the reality on the ground, which contributes to the complexity of land servicing procedures and generates informal practices to simplify the land production process. This reflects the gap between the land and urban policies advocated and the realities observed on the ground.

Moreover, land production is at the heart of social mechanisms, involving a multitude of actors such as landowners, lot purchasers, policy-makers, planning technicians, public and private developers, and land brokers. These actors compete, formally or informally, to manage the land resource to their advantage, resulting in informal practices such as land speculation, informal arrangements and clientelism. These dynamics reveal the limits of the institutional framework for access to land and the formal process of land transformation (Tillemans et al, 2012).

Finally, the third hypothesis is validated by a strong correlation between the organization of land production and urban production, underlining that Fouchana's peri-urban expansion is more the result of opportunistic practices than concerted urban planning (Dubois&Halleux, 2003; Harvey, 2010). In other words, this coexistence of land production channels has brought about major transformations in the urban landscape, transforming it from a formerly rural environment into a space marked by rapid urban expansion.

These landscape changes are concentrated along the main traffic arteries and in the vicinity of activity zones, such as the El Mghira industrial zone, where agricultural land is under heavy pressure from the demand for building land.

Conclusion

This article presents an in-depth analysis of the manufacture of peri-urban space in Fouchana, through the design, modeling and validation of a systemic model based on the articulation between land tenure mechanisms, land production and urban dynamics. Based on a sample of 220 inhabitants and 208 exploitable responses, we mobilized the PLS structural equation method to empirically test our conceptual framework. This approach ensured the reliability and validity of the constructs, confirmed the robustness of the measurement model and identified the structure of relationships between latent variables.

The results reveal a particularly strong predictive capacity of the model, especially for spatial variables, and highlight a decisive mediating effect: land mechanisms do not act directly on the urban fabric, but model land production, which in turn profoundly influences the social and spatial dynamics of the territory. This systemic diagram confirms the indirect but structuring influence of land and urban policies, while highlighting the asymmetry between normative intentions and actual practices.

As a result, our conceptual model highlights the crucial importance of land in the peri-urbanization process. The latter is influenced by a range of mechanisms that impact on the formal transformation of land. Land and urban policies play an essential role as levers capable of influencing methods of coordinating land resources, thus encouraging households to adopt strategies likely to profoundly shape landscapes over the long term. In this context, the gap between the land use defined by public authorities and its actual use is largely influenced by land production methods.

Furthermore, the land market, characterized by a high degree of economic freedom, plays a crucial role in access to land, which is mainly dominated by private ownership. This dynamic gives the private player a dominant position in the land transformation process. This structural framework shapes the practice of urbanization, influencing the way in which processes are orchestrated, taking into account a variety of technical and financial parameters. As a result, informal practices emerge, sometimes deeply rooted in the planning culture, which may ultimately prove more durable than formal rules.

Consequently, the urban fabric of Fouchana is not a planned, linear process, but a complex arrangement of territorial practices, shaped by power relationships, the structure of the land market, and the ability of actors to navigate between regulatory frameworks and the margins of circumvention. This observation highlights the centrality of land in peri-urbanization processes, not only as an economic resource, but also as an object of social and political negotiation. It calls for a rethinking of regulatory mechanisms based on actual practices, from a pragmatic and territorialized perspective, better adapted to the realities of the urban bangs of the South.

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Appendix

Questionnaire Framework

Age :

- Between 20 and 40
- Between 40 and 60
- 60 and over

Gender :

- Men
- Woman

Academic level :

- Primary
- Secondary
- University
- Illiterate

Socio-professional category :

- Liberal profession
- Civil servant
- Worker
- Retired
- Unemployed

Response level:

1 strongly disagree

2 disagree

3 neutral

4 d'accord

5 totally agree

The independent variable; Land tenure mechanisms

Social dimension

Question	Response levels				
	1	2	3	4	5
The town of Fouchana is characterized by a land-buying fever among migrants of different geographical origins and socio-professional categories.					
Land acquisition dominated by natives rather than migrants					
The formal private sector, dominated by property developers, has reinforced inequalities in land ownership in the town of Fouchana.					
Land has helped attract new socio-professional categories to the city					
Land has led to a categorization of the population entering the city according to origin					
Other factors played a part in categorizing the population					
Access to land and housing is seen as the main reason for migration to Fouchana					

Economic dimension

Question	Response levels				
	1	2	3	4	5
Theme 1: the land market					
Land in this area is a source of income and legitimization of a new status					
The land price range is between 100 and 400 DT.					
Land price range exceeds 400 dt					
The informal land market in our study area offers affordable, small-scale land products with flexible payment terms.					
The informal land market offers a variety of land products of different types and sizes					
Land prices have soared in recent years					
Investment by major new land developers in the town of Fouchana is driving up land values					
The majority of land transactions take place in the informal sector					
Land acquisition through family loans					
Land acquisition through family donations					
Land acquisition through savings					
Land acquisition through bank loan					

Political dimension

Urban policy

Question	Response levels				
	1	2	3	4	5
Administrative division (delegation/sector) facilitated urban productivity in Greater Tunis and later in the city of Fouchana					
Restrictions on political pluralism hampered the smooth running of local government before 2011					
Regional and municipal councils played an effective role before 2011					
After 2011, with the change in territorial policy, the town of Fouchana experienced good governance.					
The town council acts in the interdependence of all players					
City council practices authoritarian governance					
Decentralization has succeeded in creating a formal land market					
The State tolerates informal access to land by including informal settlements in urban planning documents.					

Land policy

Question	Response levels				
	1	2	3	4	5
Land registration generalized in the town of Fouchana					
Muslim land law is still present in Fouchana with the presence of notarial deeds.					
State-owned land at the service of development projects					
The town of Fouchana is affected by the policy of privatizing state-owned land.					
The privatization of public land is one of the factors behind the formation and development of the informal sector.					
The absence of a dissuasive property tax system leads to speculation					
State-regulated land mobilization is responsible for the segregated distribution of housing areas					

The mediator variable; Land Productions

Spatial characteristics of land production

Question	Response levels				
	1	2	3	4	5
The formal and informal sectors are characterized by land production on small plots not exceeding 200 m².					
The formal and informal sectors are characterized by land production on medium to large plots.					
The public sector was well developed in the study area, particularly in the 1990s and 2000s.					
The public sector is still present in the town of Fouchana					
We are currently witnessing the rise of the formal and informal private sector, against the eclipse of the public sector.					
Informal channels are located outside PAU boundaries					
Informal channels are located both inside and outside PAU boundaries.					
Informal land production is concentrated in the north of the city					
Informal land production is concentrated in the south of the city					
Informal land production is concentrated throughout the city					

Land practices

Practices in the informal land production sector

Question	Response levels				
	1	2	3	4	5
The informal sector in the town of Fouchana is aimed at the underprivileged and middle classes.					
Informal channels are aimed at senior government officials and large informal investors.					
The informal sector is characterized by non-compliance with town planning regulations and the absence of secure land tenure.					
The informal sector comprises the following stages: acquisition-formalization-sale (without subdivision)					
The formalization stage is often overlooked in this sector, particularly when land ownership is undivided.					
Clientelism is a common practice in the informal sector.					
Corruption is a common feature of the informal sector					
Informal arrangements between local residents and municipal officials for the right of way are characteristic of informal channels.					
With a view to regularization, the owners of informal housing estates are putting pressure on municipal officials through the impoverished population.					
Behind the informal practices mobilized by the state and local residents, there is an apparent legal order.					

Practices in the <u>formal</u> land production sector

s	Response levels				
	1	2	3	4	5
Public and private operators do not respect the sequence of land transformation stages					
Prices offered by these developers exceed the capacity of local residents					
The distribution of lots by the housing agency is a clientelist practice where the rules are out of whack.					
People who have obtained developed plots practice speculation through second-hand sales at very high prices.					
The circumvention of the rules in this sector is illustrated by the second sale of the lot without a definitive title deed.					
Informal practices in this formal public sector include exceeding the time allowed for the construction of acquired plots.					

Dependent variable: Peri-urban factory in the town of Fuchana

Social characteristics of the population

Question	Response levels				
	1	2	3	4	5
The town of Fouchana is characterized by a composite origin of the inhabited population					
There has been a change in the geographical origin of the population migrating to Fouchana					
The city is still home to a low-income population excluded from the formal land market					
Today, the city is a magnet for the modest to well-to-do classes.					
The town of Fouchana is characterized by a positive migratory balance					
The town of Fouchana has a negative migratory balance					
Social reasons for migration (marriage, home acquisition)					
The reasons for migration are economic (the search for a job)					
Commuting from Fouchana to central Tunis					
Commuting from Fouchana to neighboring towns (Zaghouan/Birmchergua/Bourbiii)					
Fouchana's population continues to grow					
Fouchana's population is growing at a steady pace					
The period between 1975 and 2004 is the most significant in terms of demographic evolution.					
After 1994, growth in the housing stock is closely linked to population growth					
Before 1994, the number of housing units did not keep pace with population growth.					

Spatial characteristics of the town of Fouchana

Question	Response levels				
	1	2	3	4	5
Theme 1: Historical aspect of the town of Fouchana					
The expansion of the town of Fouchana has been at the expense of fertile agricultural land.					
Urbanization began to accelerate in Fouchana from 1975 onwards, although it remained an outlying suburb.					
Urban development in the north is based on former cooperatives managed by the OMVM (Office de mieenvaleur du canal de Majerda).					
Theme 2: morphological and spatial extension					
The town of Fouchana-Mghira is expanding along the roads,					
The extension of the town of Fouchana-Mghira can be seen in its agglomerated nuclei					
The extension of the town of Fouchana-Mghira is characterized by sparse construction					
Urbanization fronts run northwards across farmland					
Urban development fronts run in an easterly direction towards Mhamdia					
Fouchana's urbanization fronts follow all directions					
Theme 4: Infrastructure, transport and networks					
The development and planning of national and regional infrastructure such as the RN3 and MC39 in the study area has contributed to the development of peri-urbanization.					
The town of Fouchana suffers from a lack of public transport facilities					
The town of Fouchana is not fully connected to the sewage network.					
Theme 5: Equipment and green spaces					
Fouchana suffers from a lack of green spaces and urban parks					
Educational and sports facilities have improved					

Theme 6: Centrality					
The town of Fouchana dominates and polarizes the M'hamdia area					
Fouchana suffers from low poly functionality					