Location Strategy Analysis of Logistics Centers Using GIS And AHP-Multicriteria Decision: A Case Study of Tunisia

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Abstract

Strategic logistics center's location decisions depend of several factors that can be conflicting in nature, and may cause a difficult ranking problem. The originality of this paper is based on two elements. Firstly, this work is considered as the first work on Tunisian logistics centers. Besides, this work focuses on finding the most suitable location for a set of logistics centers as a solution to government decision problem. In fact, ministry of Transport intends to promote Tunisian logistics infrastructure and reserves 1800 billion dinars at the level of the development plan and 580 ha of land for their settlements. We apply Geographic information system and Analytic Hierarchy Process analysis. Based on those techniques, regions are ranked optimally according to a set of criteria and preferences of decision makers.

Keywords*:* logistics centers, AHP, ranking problem, investment decision problem, GIS

1. Introduction

The concentration of manufacturers on their main functions favored the outsourcing of logistics operations. Consequently, this created a logistics provider function. Indeed, logistics provider is expanding its market by moving from simple storage operations to the developing of new information services, management services, assembly, repackaging, etc (Colin, 2005). Therefore, logistics became a key strategic approach for companies. Obviously, the location of logistics providers would be profitable for manufacturers. The diversity of logistics activities is accompanied by the development of new specialized activity zones and logistics centers are considered among those areas.

Logistics centers are separated entities where all logistics activities are concentrated (forwarding, goods handling, warehousing, cross-docking, etc) and play a crucial role especially for 3PL and 4 PL. Those operational hubs are centralized facilities; they manage the flow of goods to ensure efficient supply chain operations. Besides, logistics centers are considered as technological integrated centers; they use advanced technologies like automation and IA. Authors emphasize the role of logistics centers in implementing sustainable practices such as energy efficient operations and reduced carbon footprints. Furthermore, they are defined as multimodal connectivity nodes that integrate various transportations modes to streamline global and local trade and therefore support e-commerce. They are defined as adaptable facilities that enhance supply chain facilities resilience. They have other names such as: public logistics platforms, freight village, integrated freight centers, logistics park, logistics center, distribution center, central warehouse, freight terminal, transport node (Cote et al., 2021). They integrate logistics services and contribute to customer satisfaction through good quality service. Thus, location choice of those centers is important (Rushton, 2006; Özmen & Aydoğan, 2020) and should be related to firm's development strategies (Zhang, 2024).

Furthermore, this issue has often attracted the interest of authors of localization theories. It begins with the location choice of agricultural products stressing the role of transport cost as principal criteria of location choice (Von thünen, 1966). Then, it was about finding the best location for a given industry based on transport cost, spatial variation of salaries and agglomeration economies (Weber, 1929). Weber's model has been criticized for ignoring demand as a determining factor in choosing a location, for that, theory "market area" appeared and adopts the idea that the firm's location is associated with the increase of maximum net profit which contradicts Weber's theory. Through the theory of "central place", Losch (1944) considers the size of the market and the demand as decisive variables. Consumers and factors of production are thus distributed uniformly across space.

1.1. Location criteria

Location analyzes can be characterized as very complex in terms of information. The complexity is created by the multiplicity of alternative locations. Information intensity is created because analysis requires detailed information about the market, customer demand, products, transportation, and fixed costs (Rimienė and Grundey, 2007). In addition, location selection should also take into account many factors, such as (skilled) labor, markets (e.g. proximity to customers and suppliers), infrastructure (e.g transportation, water and electrical systems), and political, regulatory conditions (government policies and laws of industrial regulation) (Demirel, et al., 2010). In the same study, five criteria are proposed: market accessibility, productive units and the main commercial ports, the place must be accessible and presents a fluid transport infrastructure (especially the road infrastructure), the land must be available because logistics, through its infrastructure, is a large consumer of space since the logistics facilities occupy more space about10 000 m^2. The author also stresses the importance of the choice of soil quality since this criterion has an advantage for the builder or the developer in reducing building costs. Finally, public influence is paramount and is not negligible, especially with regard to the acquisition of land and the acceleration of procedures. Indeed, this requires in most cases the prerogatives of public authorities (Mérenne-Schoumaker, 2007).

Setting up logistics sites is complex because several parameters must be considered in the decisive process. Masson & Petiot (2012) take into account the following elements: Accessible and lower-cost transportation, an accessible market, urban congestion, real estate purchase costs, availability of labor and minimization of production costs and regulations in terms of taxation. Tomić et al.,(2014) Study the location of logistics centers in the Balkan Peninsula and define six criteria according to the types of flows (physical flows, economic flows, institutional or property flows, goods flows, information flows and other flows). Authors determine the most appropriate location using multi-criteria analysis (AHP). In addition, an assessment was made according to: proximity to the port and the airport, the distance from residential areas, accessibility to work, environmental safety, accessibility to highways, density of traffic, air pollution and building permits. Those criteria illustrate the basis for the optimal selection of logistics center location in the west of the Black Sea and using the multi-criteria method (Electre) (Uysal & Yavuz, 2014; Hamri & Mraihi, 2025).

The availability of skilled labor, proximity to production and the availability of support services, such as energy supply and waste management are also considered (Ren et al., 2010). Nong (2022) identify the following criteria to locate a distribution center: the distance (notably distance to suppliers, to market, to airport, to highway, to port, and to railway), cost (land cost, installation cost, logistics cost and labor cost), service summarized on storage convenience and forwarding services, then infrastructure (area size and diversity of transportation services) and finally human resources availability.

Issues related to regional development policies, legislation and tax incentives are taken into account by different studies (Lee et al., 2009; Ren et al., 2010). Not to mention the study of Strale (2010) on the location of logistics companies in an urban regions of North-West Europe. The author find that the spatial distribution of logistics activities strengthens the trend of the rest of the economic activity and, the following factors are used in location choice: Closeness to the target market, ideal accessibility conditions, and cost-effective land prices are essential considerations. Kirillov & Tselin (2015) outline a framework for constructing a distribution network based on a detailed analysis of regional industrial and logistical capabilities. Their model includes nine key factors: the business environment, economic appeal (encompassing both overall and logistical expenses), ecological considerations, nearness to consumer hubs, the level of competition, access to skilled workers, closeness to suppliers, political stability, and strategic competitive benefits. Otherwise, Fuzzy method is applied for a localization problem of logistics distribution centers in a fuzzy environment (Wang et al., 2012). Moreover, a fuzzy quantified SWOT procedure is presented for assessing the location of an international distribution platform (Lee & Lin, 2008). Also, Demirel et al., (2010) present an ARAS-F method to select the most suitable site for a logistics platform. The following criteria were taken into account: the characteristics of the labor, transport infrastructure, investment cost, possibility of expansion and proximity to the market. We can also cite the technique of ordering preference by similarity with an ideal solution (TOPSIS), which is used to optimize the location of an urban distribution platform by considering accessibility, security, connectivity to multimodal transport, costs, environmental impact, proximity to customers, proximity to suppliers, availability of resources, regulatory compliance, possibility of expansion, and quality of service (Awasthi, & Chauhan, 2012). Furthermore, an Axiomatic Fuzzy Set and TOPSIS methodology is presented for a logistics center location. Besides, authors use four selection criteria, traffic, communication, land area and price (Li & Liu, 2011). In addition to AHP and TOPSIS (Stopka, 2022), other methods are integrated by Kuo (2011): (AHP / ANP), TOPSIS, and DEMATEL techniques. Those methods determine an optimal location for an international distribution platform taking into account the volume of trade, the resistance of the location, the convenience of transport, transshipment time, port storage facilities, port operating system and shipping line density. A Turkish study presents a new integrated GIS-based MCDM model comprising fuzzy SWARA and CoCoSo is introduced to literature to address the location selection problem for a logistics center. In this research, the outcomes of the CoCoSo technique are evaluated alongside those of several other multi-criteria decision-making (MCDM) methods, including COPRAS, VIKOR, ARAS, MOORA, and MABAC, to assess the reliability and precision of the results produced by the CoCoSo approach. Criteria are based on distance (to surface water, settlement area, and disaster center), population density, proximity to (Railway highway, airport, and industrial area), cost of land (Ulutaş et al., 2020). The Best-Worst Method (BWM), a robust multi-criteria decision-making approach, is well-suited for addressing highly intricate processes. It enables decision-makers and policymakers to enhance their comprehension of the system under study. This methodology has been extensively applied in various real-world scenarios, as highlighted by Özmen and Aydoğan (2020).

1.2. Context of the Study

Many questions are asked about the performance of the Tunisian logistics sector. According to the WB report (2016)[1] which classifies the countries according to the LPI: Tunisia went from 60th world rank in 2007 (LPI=2.76) to 110th in 2016. For the same year, it ranks 3rd in the Maghreb (LPI = 2.5) after Algeria (2.77) and Morocco (2.67). In 2018, Tunisia is at 105th world position (LPI=2.57; last value in 2018 there is no value mentioned in 2023 WB report). This report notes "a deficit in logistics infrastructure" and recommends promoting investment in infrastructure in order to adapt to the production and consumption needs of the Tunisian regions. Following this report, the Ministry of Transport is launching a logistics development strategy and confirms the importance of installing a set of public logistics centers.

Ministry of Transport intends to promote Tunisian logistics infrastructure and reserves 1800 billion dinars at the level of the 2023-2025 development plan and 580 ha of land for their settlements. We emphasize the importance of an optimal choice to locate those logistics centers. Hence the interest of this paper which has the overall objective of defining a decision support tool for priority ranking logistics centers location.

As explained above, there is no especial method or criteria to solve location logistics centers problem (Cote et al., 2021). The majority of studies on location choice are based on multi-criteria methods. The application of multi-criteria decision-making (MCDM) in different areas of sustainable development engineering is considered as an important issue (Tian, 2023; Sawicki and sawicka, 2025) and AHP is one of the most used MCDA methodologies which include opinion of different stakeholders and uses this in compiling and ranking alternatives. This methodology incorporates objective and subjective criteria. Literature shows that AHP is generally used for planning, resources allocation and ranking preferences. However, this decision problem is mainly a ranking location of logistics centers. It presents many criteria and alternatives which are conflicting. AHP presents a solution to the strategy makers to help them to the decision making process. In other hand, we opt for this MCDA because this evaluation problem requires multi-level evaluation methodology by combining criteria and sub criteria (quantitative and qualitative).

Although authors used different criteria to find the appropriate location choice, those criteria may be grouped in the same type: economic factors, social factors, financial factors (cost) and environmental factors. Accordingly, in this study, AHP is used with a set of 7 criteria. Those criteria are adopted from literature review and will be reviewed by experts on the Delphi survey.

2. AHP method

The preferences of the various stakeholders differ significantly. The interests of local residents are focused on social aspects, while investors, logistics operators and local businesses are particularly interested in economic and market-oriented issues. Thus, we choose the multicriteria analysis to solve this decision problem: AHP which is introduced by Saaty (1980). Analysis shows that this process consists of four steps. Firstly, we define the problem and state the goal. Then, we define the criteria that influence the goal and finally, we use paired comparisons of each factor, with respect to each other. The result forms a comparison matrix with calculated weights, ranked values, and consistency measures (Melvin, 2012):

2.1. Relevant criteria

There is a set of criteria that can be studied in relation to the choice or ranking of alternatives. In order to define the relevant criteria, hierarchical structure of criteria used in this research for the choice of logistics centers location consists of 4 group criteria and 7 criteria (table 1).

Table 1.The hierarchical structure of the relevant criteria

Criteria Group	***Criteria Level***	***Type***
Cost	C3: Land Price	Numerical
Environmental	C7: Respect of the environment	Numerical
Economic and social	C1: density of road transport infrastructure C2: Socio economic development C4:Level of transportation and logistics competitiveness C5:Investment attractiveness C6:Industrial production	Numerical

One of the principal characteristic of multi-criteria decision-making is that each criterion may not have the same weight. To be objective in the mechanism of determining the importance of each criterion, we adopt Delphi method. It is employed to determine

[1] World bank: Connecting to Compete : Trade Logistics in the Global Economy.

initial weight of the relevant criteria. Process for defining the initial weight was carried out in three steps: Define the relative weight of every criteria group (R_j, j=1..3), find the relative weight of every relevant criterion (k_i; i=1..7), corrections of relative weight of criterion with its group weight (w^i_i ; i=1..7). In this study, survey is limited to criterion weight, since we are more interested in criterion than the group.

The Delphi method relies on structural surveys. It is based on intuitive responses of survey's contributors. Thus, it shows qualitative as well as quantitative information. It is an exploratory, anticipating method (Linstone, 1975). According to authors, this method is an expert survey based on different cycles. Indeed, from the second cycle and subsequent cycles of the survey, the results of the previous cycle are given in return. Therefore, participants respond from the second round influenced by the opinion of others participants. Consequently, the Delphi is "a method for structuring a group communication process strongly structured, in which complex issues where knowledge is uncertain and incomplete.This technique is judged by experts using an iterative method" (Häder& Häder, 1995).

The survey was sent to 68 participants (industrial firms, logistics providers, researchers, residents, local community, members of the decision committee at the Ministry of Transport), only 53 responded. Indeed, the first round of the survey lasted 4 weeks because we did not receive answers from the experts at the same time. The results of the first round clearly show a consensus for criteria C1, C2 and C3. In addition, we returned the survey for a second round while asking participants to review the answers to criteria C4, C5, C6 and C7. We also re-explained these criteria to the experts while trying to rephrase the questions. We obtained consensus in the second round as follows: C4 = 52%; C5 = 54%; C6 = 62%; C7 = 59%.
This research included local residents, local firms, logistics service providers and spatial planners, which determined criteria weighting through a survey and results of criteria weighting are respectively: w_1=0.420; w_2=0.010; w_3=0.060; w_4=0.010; w_5=0.200; w_6=0.210; w_7=0.090.

Then, we define 24 alternatives (Table2) which correspond to the alternative locations for the logistics centers across the Tunisian territory. They are defined as follows:

Table 2. The hierarchical structure of the relevant criteria

Alternative	State	Alternative	State
A1	Ariana	A13	Manouba
A2	Bizerte	A14	Medenine
A3	Béja	A15	Monastir
A4	Ben Arous	A16	Nabeul
A5	Gabes	A17	Seliana
A6	Gafsa	A18	Sfax
A7	Jendouba	A19	Sidi Bouzid
A8	Kairouan	A20	Sousse
A9	Kasserine	A21	Tataouine
A10	Kebeli	A22	Tozeur
A11	Le kef	A23	Tunis
A12	Mahdia	A24	Zaghouan

Comparison of alternatives per criterion
The alternatives compared to the criteria on the basis of the scale of Saaty (1980) is presented respectively in the tables of appendices 1, 3, 5, 7, 9, 11 and 13 where you can see their importance. For example, for Annex 1, the relation A1: A3 for C1 = 1/2 means that the alternative has a low predominance compared to another alternative for the first criterion.

Calculation of the priority vector

In this step, we sum the columns of the table in appendix 1, we divide each element of the table by the total of the column: a_{11} = 1 / (33.73) = 0.03; a_{12} = 1 / 31.71 = 0.03; a_{13} = 0.5 / 19.14 = 0.03; a_{14} = 0.5 / 20.89 = 0.02…. etc. Then, we calculate the average of the components of each row of this table to obtain a table which represents the vector of the eigenvalues (comparison alternatives vector) compared to the first criterion (Annex 2). The vector of priority is represented by the last column of array named VP1 (We deduce the priority vectors VP2, VP3, VP4, VP5, VP6 and VP7 respectively from the other criteria Appendices 2, 4, 6, 8, 10, 12)

$$\frac{1}{24}\begin{bmatrix}0.738\\0.805\\1.296\\1.185\\0.488\\0.714\\1.376\\1.013\\1.035\\0.129\\1.068\\0.805\\1.919\\0.805\\1.879\\1.680\\1.150\\0.433\\1.376\\0.684\\0.224\\0.265\\1.669\\1.219\end{bmatrix}=\begin{bmatrix}0.031\\0.034\\0.054\\0.049\\0.020\\0.030\\0.057\\0.042\\0.043\\0.005\\0.045\\0.034\\0.080\\0.035\\0.078\\0.070\\0.048\\0.018\\0.057\\0.028\\0.009\\0.011\\0.070\\0.051\end{bmatrix} \text{(VG)}$$

We thus obtain the vector VG above. Then, we carry out a multiplication of the vector VG by the matrix of comparison of the alternatives for the criterion C1 (appendix 4), we thus obtain, the following vector VF:

$$\begin{bmatrix}0.749\\0.819\\1.323\\1.212\\0.496\\0.726\\1.408\\1.035\\1.059\\0.131\\1.092\\0.819\\1.966\\0.867\\1.925\\1.718\\1.177\\0.441\\1.408\\0.696\\0.228\\0.270\\1.707\\1.248\end{bmatrix} \text{(VF)}$$

The vector VF will be divided by the vector VG as follows to obtain λ_i:

$$\begin{bmatrix} 0.749/0.031 \\ 0.819/0.034 \\ 1.323/0.054 \\ 1.212/0.049 \\ 0.496/0.020 \\ 0.726/0.030 \\ 1.408/0.057 \\ 1.035/0.042 \\ 1.059/0.043 \\ 0.131/0.005 \\ 1.092/0.045 \\ 0.819/0.034 \\ 1.966/0.080 \\ 0.867/0.035 \\ 1.925/0.078 \\ 1.718/0.070 \\ 1.177/0.048 \\ 0.441/0.018 \\ 1.408/0.057 \\ 0.696/0.028 \\ 0.228/0.009 \\ 0.270/0.011 \\ 1.707/0.070 \\ 1.248/0.051 \end{bmatrix} = \begin{bmatrix} 24,358 \\ 24,418 \\ 24,502 \\ 24,541 \\ 24,427 \\ 24,386 \\ 24,570 \\ 24,513 \\ 24,550 \\ 24,417 \\ 24,536 \\ 24,418 \\ 24,585 \\ 24,449 \\ 24,588 \\ 24,551 \\ 24,560 \\ 24,446 \\ 24,570 \\ 24,433 \\ 24,457 \\ 24,456 \\ 24,551 \\ 24,552 \end{bmatrix} (\lambda_i)$$

Calculation of the eigenvalue λ_{max}

$$\lambda_{max} = \frac{1}{n}\sum \lambda_i = \frac{24,358 + 24,418 + 24,502 + 24,541 + ... + 24,552}{24} = 24.493;$$

$$C_1 = \frac{\lambda_{max} - n}{n-1} = \frac{24.493 - 24}{24 - 1} = 0.021$$

$$C_R = \frac{C_1}{R_1} = \frac{0.021}{0.74} = 0.028$$

The RI (random index) is taken from the Saaty table (1980) on the basis of the number n which represents the alternative. The study prsents twenty-four alternatives; n = 24 and the value of the random index is 1.6526. Indeed, it is very important to mention that the degree of consistency for the first criterion C1 is 0.021, which means that the result is valid, because the results are valid if this degree is less than 0.10.

3. Results and discussion

Based on the results of the priority vector VP1 (appendix 2), for C1, i.e. the density of the road infrastructure, the highest value is for A13 (Manouba), while A10 (Kebili) represents the state with the lowest value. The approach for evaluating the alternatives for the other criteria is the same. Therefore, the comparison of alternatives for criterion C2 (see VP2 appendix 4), i.e, Socio-economic development, the best alternative is A23 (Tunis) and at the last rank we find A7 (Jendouba). Indeed, for criterion C3, the cost of investment, we note that the investment will be the less expensive for A7 (Jendouba) in order to encourage investment in this region.The A4 location (Ben Arous) has the most expensive land due to a slightly higher standard than the rest of the country (see VP3 appendix 6). However, for criterion C4, the level of transport and logistics competitiveness, A4 (Ben Arous) has the highest level. However, A10 (Kebili) has the lowest level (see VP4 appendix 8). For C5, based on VP5 appendix 10, A21 is the most attractive state for investment. Criterion C6 measures the industrial production in the region and the best location is number fifteen A15 (Monastir), according to this criterion, A9 (Kasserine) is the least favorable location.

Finally, criterion C7, refers to the friendliness of the environment, the location with the most favorable corresponds to A7 (Jendouba) on the other hand, location A23, the capital Tunis, has the lowest level (more emissions due to congestion).

After having completed the previous steps, the classification result is obtained by multiplying the weight of each criterion by the priority vectors of the alternatives by criteria. We obtain the following results for C1:

$$A1= W_1*VP1+W_2* VP2+W_3* VP3+W_4* VP4+W_5* VP5+W_6*VP6+ W_7* VP7=\mathbf{0{,}772}$$

We performed the same calculation for the rest of the criteria and we obtained the following classification vector in Table 3:

Table 3.Classification vector

Alternative	Result
A1	0,772
A2	1,679
A3	0,902
A4	1,205
A5	0,933
A6	0,883
A7	0,982
A8	0,738
A9	0,744
A10	0,514
A11	0,771
A12	0,754
A13	**1,944**
A14	0,688
A15	1,539
A16	1,499
A17	0,913
A18	0,829
A19	0,846
A20	1,021
A21	1,285
A22	0,455
A23	1,22
A24	0,929

The GIS results (Fig.1) show seven maps, each of them correspond to a selection criterion

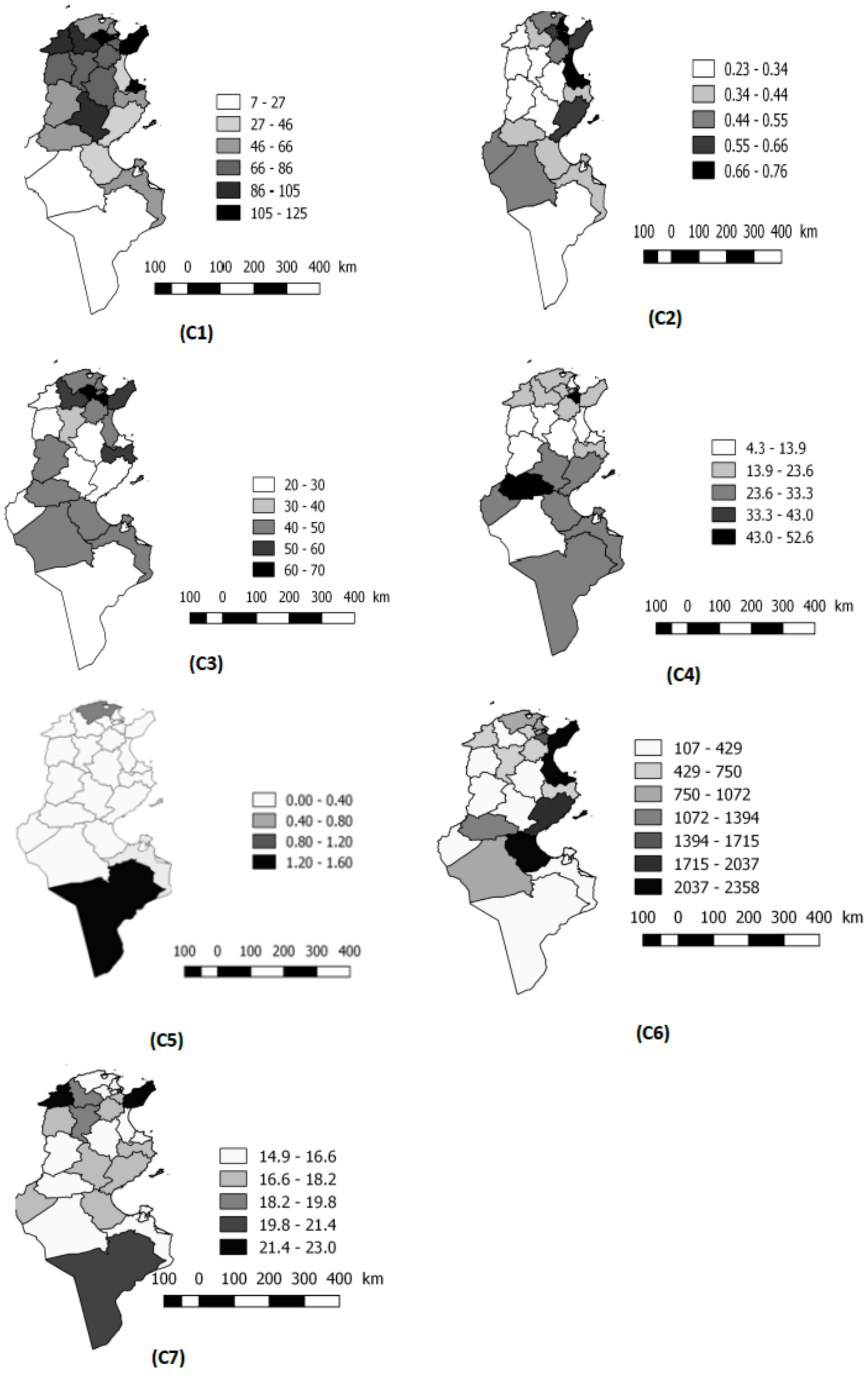

Figure 1.Classification by criteria

The maps shows that:

- The road density is higher in the north east of the country (Manouba, Nabeul), medium in the center and very low in the south (with the exception of the southern coast regions).

- The coastal regions are the most developed according to the RDI (regional development indicator), whereas the northwest and central west regions are the least developed.

- The northern and central eastern regions, mainly the coastal area, have more expensive land compared to those located in the center and south of the country.

- Logistics firms are concentrated in the north-east (Ben Arous), central and south-east regions (coastal area), and particularly near to transport hubs (especially airports and ports)

- Three free zones are located in: Bizerte, Tataouine and Béja

- Industrial production is concentrated especially along the Tunisian coast from north to south.

We choose to classify locations in three categories according to their ranks: the first eight states at the level of the first category (high location priority), the following eight for a second category (medium location priority) and the last eight for a third category (low location priority). Fig 2 (b) shows that the majority states of class 1 are located on the Tunisian coast (north east, center east and south east). These are coastal regions (Manouba, Bizerte, Monastir, Nabeul, Tunis, Ben Arous, Sousse). States of each class are shown in table 3:

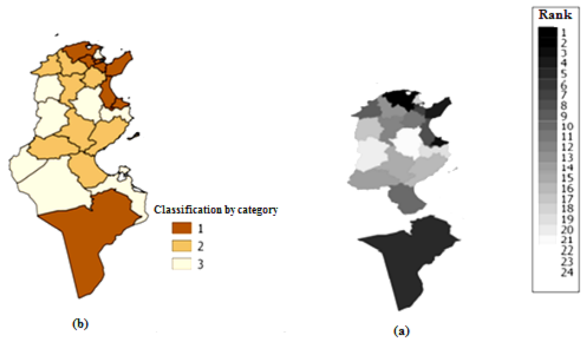

Figure 2.Suitable region

Table 3 shows three states rankings. For the first class, the average of its road density is around 0.831 and the average of industrial production is 1380 thousand tones. For the second class, the average density is around 0.684 and the average industrial production is 7461 thousand tones. Finally, for the third class, the average of its road density is around 0.5 while it is around 3601 thousand tones for industrial production.

Table 3 Classification of regions

	1 st class			2 nd class			3 rd class	
Rank	Alternative	State	Rank	Alternative	State	Rank	Alternative	State
1	A13	Manouba	9	A7	Jendouba	17	A1	Ariana
2	A2	Bizerte	10	A5	Gabes	18	A11	Le kef
3	A15	Monastir	11	A24	Zaghouan	19	A12	Mahdia
4	A16	Nabeul	12	A17	Seliana	20	A9	Kasserine
5	A21	Tataouine	13	A3	Béja	21	A8	Kairouan
6	A23	Tunis	14	A6	Gafsa	22	A14	Medenine
7	A4	Ben Arous	15	A19	Sidi Bouzid	23	A10	Kebeli
8	A20	Sousse	16	A18	Sfax	24	A22	Tozeur

This is may be explained as follow: the first class of states (Manouba, Bizerte, Monastir, Nabeul, Tataouine, Tunis, Ben Arous, Sousse) are supposed to be the most attractive investments in logistics infrastructure. This also supposes the existence of a strong correlation between the establishment of logistics centers and investments in road infrastructure and those of industry on the other hand, it is absolutely normal to discover this correlation as several authors have shown, The existence of logistics centers and their activities are conditioned by the presence of physical flows, which are the outputs of industries and constitute either supply or distribution flows.

4. Conclusion and future work

Selecting the location of logistics platforms is a complex, multi-step process. As we indicated in the previous sections, it can be divided into two main phases, the first lies in ranking regions according to weighted selection criteria and the second by specifying the precise location at the level of each region. We are limited to the first stage for lack of data on the availability of land.

- Results show a correlation between the establishment of logistics platforms and investments in road infrastructure and those in industry: as several authors have shown, to the extent that the existence of logistics centers and their activities are conditioned by the presence of physical flows. These are the outputs of industries and constitute either supply or distribution flows. Logistics flows, whose costs become very high once the logistics centers, are far from production or consumption centers in addition to the lack of a better quality road infrastructure. The high density of roads in first class of states has the advantage of offering high accessibility to platforms. Accessibility generally assessed both in terms of road transport costs and proximity (economy of scales, etc.). In the same context, the location of logistics centers in regions with high industrial investments, as our results show, can be explained by the ease of cooperation generally sought between manufacturers and logistics service providers (LSP). Cooperation that can take the form of partnerships, sharing of the same information system or even alliances such as in the case of China (Häder& Häder, 1995) or synergies such as in the French case (Bounie, 2017). The outsourcing of some logistics functions (storage, warehousing, packaging, consultancy and studies, etc) are logistical solutions that can be envisaged depending on the type of partnership once the logistics centers are close to manufacturers.
- Offer a decision support tool for a decision problem: in the regional assessment process, the preferences of the different stakeholders differ significantly. The interests of local residents are focused on social aspects, while investors, logistics operators and local businesses are particularly interested in economic and market-oriented issues. Through the Delphi survey we tried to reconcile the preferences of the various stakeholders.
- A cartographic analysis shows that the majority of class 1 are located on the Tunisian coast (north east, center east and south east), therefore we highlight a problem of economic imbalance between the regions.

The AHP multi-criteria method is universal in nature and can be applied in the selection of any logistics center location and any other element of the logistics infrastructure, including warehouses, distribution centers. It can be extended to specify the site selected.

References

Awasthi, A., & Chauhan, S. S. (2012). A hybrid approach integrating Affinity Diagram, AHP and fuzzy TOPSIS for sustainable city logistics planning. *Applied Mathematical Modelling*, *36*(2), 573-584.

Bounie, N. (2017). *La zone d'activité logistique comme levier de développement économique des territoires* (Doctoral dissertation, Université Paris-Est).

Colin, J. (2005). Le supply chain management existe-t-il réellement ? *Revue Française de Gestion*, n° 156, pp. 135-149.

Cote, M. A. A., Polanco, D. F. S., & Orjuela-Castro, J. A. (2021). Logistics platforms-trends and challenges. *Acta logistica*, *8*(4), 341-352.

Demirel, T; Demirel, N. C., and C. Kahraman, C.(2010). Multi-criteria warehouse location selection using Choquet integral, *Expert Systems with Applications*, vol. 37, no. 5, pp. 3943–3952.

Häder, M; Häder,S.(1995). Delphi und Kognitions psychologie: Ein Zugang zur theoretischen Fundierung der Delphi-Methode, in*: ZUMA-Nachrichten*, vol. 37, 19.

Hamri, A; Mraihi, R. The selection of the logistics platform's location based on ELECTRE. World Journal of Advanced Research and Reviews. 2025, 27(02), 2157-2169. Article DOI: https://doi.org/10.30574/wjarr.2025.27.2.1703.

Kirillov, A. V., & Tselin, V. Y. (2015). Model for Building a Distribution Network Based on the Multivariate Analysis of the Industrial and Logistical Potential of Regions. *Ekonomika Regiona= Economy of Regions*, (4), 336.

Kuo, M. S. (2011). Optimal location selection for an international distribution center by using a new hybrid method. *Expert Systems with Applications*, *38*(6), 7208-7221.
K-L. Lee, S-C. Lin, A fuzzy quantified SWOT procedure for environmental evaluation of an international distribution centre, *Information Sciences*, Vol. 178, No. 2, pp. 531–54, 2008.

Lee, K. L., Huang, W. C., & Teng, J. Y. (2009). Locating the competitive relation of global logistics hub using quantitative SWOT analytical method. *Quality & Quantity*, *43*, 87-107.

Li, Y., Liu, X., & Chen, Y. (2011). Selection of logistics center location using Axiomatic Fuzzy Set and TOPSIS methodology in logistics management. *Expert systems with applications*, *38*(6), 7901-7908.

Linstone, H. A., & Turoff, M. (Eds.). (1975). *The delphi method* (Vol. 1975, pp. 3-12). Reading, MA: Addison-Wesley.

Lösch, A. (1944). Die räumliche ordnung der wirtschaft. *(No Title)*.

Masson, S., & Petiot, R. (2012). Attractivité territoriale, infrastructures logistiques et développement durable. *Les Cahiers Scientifiques du Transport-Scientific Papers in Transportation*, *61*.

Melvin, A. (2012). *Decision-Making using the Analytic Hierarchy Process (AHP) and SAS/IML, Social Security Administration, Baltimore, MD. SESUG, SD-04, 1-12*.

Mérenne-Schoumaker, B. (2007). La localisation des grandes zones logistiques. *Bulletin de la Société géographique de Liège*, (49).

Nong, T. N. M. (2022). A hybrid model for distribution center location selection. *The Asian Journal of Shipping and Logistics*, *38*(1), 40-49.

Özmen, M., & Aydoğan, E. K. (2020). Robust multi-criteria decision making methodology for real life logistics center location problem. *Artificial Intelligence Review*, *53*, 725-751.

Ren, Y. C., Xing, T., Quan, Q., & Zhao, G. Q. (2010). Fuzzy cluster analysis of regional city multi-level logistics distribution center location plan. In *Quantitative Logic and Soft Computing 2010: Volume 2* (pp. 499-508). Springer Berlin Heidelberg.

Rimienė, K., & Grundey, D. (2007). Logistics centre concept through evolution and definition. Engineering economics, 54(4).
Saaty, T. L. (1980). The analytic hierarchy process (AHP). *The Journal of the Operational Research Society*, *41*(11), 1073-1076.

Sawicki, Piotr, and Hanna Sawicka. "Simulation and MCDA-based framework for border crossing process design with static and dynamic control of passenger flow." *Archives of Transport* 73.1 (2025): 99-129.

Strale, M. (2010). La localisation des entreprises logistiques et le positionnement des régions urbaines nord-ouest européennes. *Belgeo. Revue belge de géographie*, (1-2), 119-134.

Stopka, Ondrej, Paweł Droździel, and Vladimir L'upták. "Modeling the designs in terms of logistics service center placement: a case study." *Archives of Transport* 64.4 (2022): 59-71.

Tian, G., Lu, W., Zhang, X., Zhan, M., Dulebenets, M. A., Aleksandrov, A., ... & Ivanov, M. (2023). A survey of multi-criteria decision-making techniques for green logistics and low-carbon transportation systems. *Environmental Science and Pollution Research*, *30*(20), 57279-57301.

Tomić, V., Marinković, D., & Marković, D. (2014). The selection of logistic centers location using multi-criteria comparison: case study of the Balkan Peninsula. *Acta Polytechnica Hungarica*, *11*(10), 97-113.

Ulutaş, A., Karakuş, C. B., & Topal, A. (2020). Location selection for logistics center with fuzzy SWARA and CoCoSo methods. *Journal of Intelligent & Fuzzy Systems*, *38*(4), 4693-4709.

Weber, A. (1929). *Theory of the Location of Industries*. University of Chicago Press.

Uysal, H. T., & Yavuz, K. (2014). Selection of logistics centre location via ELECTRE method: A case study in Turkey. *International Journal of Business and Social Science*, *5*(9), 276-289.

Von Thünen, J. H. (2022). *Der isolierte staat in beziehung auf landwirtschaft und nationalökonomie*. Walter de Gruyter GmbH & Co KG.

Wang, Y., Ma, X. L., Wang, Y. H., Mao, H. J., & Zhang, Y. (2012). Location optimization of multiple distribution centers under fuzzy environment. *Journal of Zhejiang University Science A*, *13*(10), 782-798.

Zhang, P. (2024). A study on the location selection of logistics distribution centers based on e-commerce. *Journal of Knowledge Learning and Science Technology ISSN: 2959-6386 (online)*, *3*(3), 103-107.