

The selection of the logistics platform's location based on ELECTRE

Ahlem Hamri* and Rafea Mraih

Department of economics. Higher School of Business of Tunis. Manouba 2010. Tunisia.

World Journal of Advanced Research and Reviews. 2025, 27(02), 2157-2169

Publication history: Received on 27 April 2025; revised on 25 August 2025; accepted on 29 August 2025

Article DOI: <https://doi.org/10.30574/wjarr.2025.27.2.1703>

Abstract

This paper focuses on finding the most suitable location for the logistics platforms in Tunisia. Strategic global logistics platform's location decisions require several factors that can be conflicting in nature. and may pose a difficult ranking problem. This paper uses ELECTRE III. Based on this multicriteria decision making method. regions are ranked from the best to the worst for the location of logistics platforms according to a set of alternatives and a family of criteria and their evaluation through decision maker's preferences.

Keywords: Logistics Platforms; Ranking Problem; Multicriteria Decision Making Method; ELECTRE III

1. Introduction

Logistics infrastructure can be defined as a pivotal tool of flow management. it allows storage. sorting. consolidation and burst of products flows [1]. But according to the context, this word refers to a specific equipment (Warehouse sorting center) or an activity area regrouping several equipments [25]. In fact. it can be a logistic site which is a specific logistic activity area that may be named park or platform; or a logistic hub which consolidates several logistic sites in the same perimeter and finally. it is named logistic area in a wider geographic scale. On a global scale. and in Europe [8. 25. 14] note a big polarization of logistic implantations which are condensed in space. However. this is a general phenomenon for all logistic infrastructure types. Joignaux [10] speaks about a double dimension of logistic infrastructures: Infrastructural dimension and services dimension. In fact. the first one refers to materials and physical dimension which is related to investments. Logistic infrastructures are a support of development of production and services activities. Perrat and Zimmerman [18] explain that the aim of public authorities in not attracting investments but to ensure their sustainability.

The selection of optimal logistic infrastructure has become a decisive factor in supply chain performance [2]. Indeed, public authorities are interested to those logistic implantations because they represent an essential object of development and spatial planning [1, 19, 24, 17] and should be related to firm's development strategies [34].

2. Literature review

The analysis's results of Merenne-Schoumaker [15] show that logistic sector location is based on both industrial and services location logic. Indeed. they cite four factors which close logistic to the industry: spaces built and not built. narrow links with the transport infrastructure (Mostly Road. railway and maritime transport). and skilled labor (notably for manual tasks)) and nuisances caused (noise. traffic. pollutions...). There is Two other factors bring logistics closer to service: the relationship with customers and the weight of the real estate in location choice. However. they point out logistic as a specific sector which worth a full place in the economic activities location. We can add the findings of Hesse-Rodrigue [8]. in one hand. best accessibility and possible nearby with customers. in other hand. low cost of installation. Industrial location models appeared in the 19th century. they aimed to explain economic organization in

* Corresponding author: Ahlem HAMRI.

space against transportation cost. Von Thünen model [31], which covers ground rent of agricultural crops; although it looks simple, we can use it in land use for areas of economic activity (industrial areas are included). Also, Alfred Weber model [32] is interested in the optimal location of production activities. In fact, Weber [32] finds that the transport is the base of the model because it plays a primary role in the implantation choice. The best location minimizes supply burden of primary materials, energy and finished product expedition.

Lösch [13] built similar models to explain the location choice of commercial and administrative services. Theoretical models of Christaller and Lösch are known as « central locations' theory ». The transposition of this model to the Logistic platform location must include transportation cost upstream and downstream. Hotelling models [13] are models of spatial competition which define equilibrium location of many companies in competition, when demand is spatially dispersed. Also, company location models and spatial competition models are tools that enlighten logistic activities location choice.

Owen and Daskin [16]; Farahani and Hekmatfar [6] define the location problem as a way to find a correct place of an infrastructure in a studied area, and we should consider two essential elements: the appropriate constraints and decision maker's (DM's) preferences. In addition, the location problem can be applied in different fields and can concern different categories of sites/facilities [5].

Several methods and approaches have been used in order to solve this question, including: mathematical model [7], selection and ranking of considered sites [11, 21]. Additionally, the location problem has an important contribution in logistics, where it refers to ranking or selecting the most desirable location of logistics sites. The question of logistics location is considered as a typical problem with the development of logistics in the world and it refers to choose the appropriate placement of logistics platforms which are separate entities working in a secured area, within which all logistics activities (transportation and forwarding, material handling, warehousing, inventory management, cross-docking, intermodal trans-shipment, physical distribution of goods) are executed on a commercial basis. In the modern concepts of 3PL and 4PL [24] logistic platform plays a crucial role of logistics service integrator that provides customers with a comprehensive, high-quality service and links all possible transportation modes.

Finally, Savy [25] and Joignaux [10] agree on the importance of logistic activities location which is a primordial factor in industrial location in 19th century and probably an important element for territory organization in the 21st century. So, which factors determine location logistic activities?

2.1. Logistic activities: location factors

The implementation of a logistics site is a complex decision where the parameters to consider are numerous. In fact, professionals cite five factors which determine Logistic platform locations: market, accessibility and infrastructures availability, ground cost and role of public authorities. These factors are confirmed by the studies of major international consultants as Buck [4] and labor agencies where Cushman and Wakefield studies the "top" locations for logistic centers. In 2004, the study includes 34 regions NUTS 2 and 61 regions in 2006. However, these study is based on a multicriteria analysis which includes six fields (cost, transport system, accessibility, buildings and terrains, labor and Know-how) and 19 criteria). Merenne-Schoumaker [15] quoted five criteria for ranking the 15 first regions NUTS2 of northwestern Europe on the basis of logistic performances: proximity to market, accessibility of location and availability infrastructure, Availability and cost of land and building (warehouse exceed 10 000 m² and may form hubs of 60000 to 80000 m²), Availability, cost and qualifications of the labor and finally the role of public authority.

Żak and Węgliński [33] have proposed a set of 9 criteria in order to select the most desirable area/region for placing the logistic platform on Poland which are (Condition of transportation infrastructure – [km/100km²], Economic development, Investment cost – [\$/m²], Level of transportation and logistics competitiveness – [%], Investment attractiveness – [km²], Transportation and logistics attractiveness – [mln tkm], Social attractiveness – [points], Environmental-friendliness – [points], and Safety and security – [points]). Issam and Bouzidi [9] propose 15 criteria in order to judge the appropriateness of industrial facilities location demonstrating the decisive character of logistics in the industrial positioning of « CASABLANCA-SETTAT »: the size, accessibility, Constructability, land management, regulation and servitude, environmental impact, impact on landscape, urban impact, site security possibility, showcase Effect, positioning, proximity to industrial development, Proximity of residential and equipments, Interest from investors, market services. On the other hand, Tomić [27] studies the location of logistic centers in the Balkan Peninsula. Indeed, he defines six criteria according to flows types (physical flows, economic flows, institutional or ownership flows, goods flows, information flows and other flows). Then, Masson & Petiot [14] confirm that establishing a site is a complex decision because it requires numerous settings and they set eight location factors: accessibility and transport cost, access to market, location costs, cost and availability of factors of production, politic and regulatory factors, factors

related to logistic chain organization. externalities and territorial assets. In addition. Uysal and Yavuz [29] carried out an evaluation of logistics center location in Turkey according to ten criteria: closeness to airport and port. proximity to residential areas. accessibility to labor. environment security. accessibility to highways and linking roads. substructure. traffic density. air pollution. building site.

Lee et al. [12] mixed quantitative and qualitative criteria. related to market. labor. regional development policies. tax. and legislation. Ren et al. [22] and Tu et al. [28] take into consideration the availability of support services (energy provision and waste management). Finally. Strale [26] studies a location of a sample of logistic companies (the Northwestern European urban regions) in order to find location factors and he concludes. in one hand. that spatial distribution of logistic activities strengthens trend of the rest of economic activity and in other hand. it is a classic economic geography which is based on classic factors (proximity to the market. optimal accessibility conditions and reasonable land prices) which shows the need to well managing logistic activities distribution and well choosing location factors.

3. Tunisia: Efficiency of logistic sector

Whatever the country. in the world. decision makers. deal with regional inequalities. Tunisia. suffers from this problem. 56% of population and 92% of industrial companies concentrated on three big cities: Tunis. Sfax. and Sousse. Those cities representing 85% of GPD [20]. However. those regional inequalities are caused by economic politics. In fact. there was a regional imbalance in Tunisia (in equipments and infrastructures) since the colonial period and it becomes clearer after independence and this has an effect on regional territorial attractiveness. In fact. regions of the east coast attracted more investments than the others regions of the country. Thus. they have more flows of services and goods which create as well as zones of influence. However. the other regions were forgotten which leads to imbalance in wealth. For this purpose. a big wealth is concentrated on the coast: where 68% of population. 75% of added value. 95% of industrial and touristic economy. On the other hand. the other regions inside the country (Jendouba. Sidi Bouzid. Siliana et Kasserine) have 33% of population and are poor because they have the lowest level of development, this is explained by their employment and wealth levels: high unemployment level (up to 29% for kasserine). low density of business (0.2 against 3.1 for Tunis). A high level of poverty (27.5% for Sidi Bouzid against 6.9% for Tunis) [3]. In fact. Tunisia has 605 000 unemployed persons in the first quarter of 2014. Unemployment is at 15.2 % of the labor force (3 923 200 individuals). Joblessness touches especially the south and west of the country. It grows over the time in 2011 (up to 43.3 % compared to 2010) by the decrease of growth (-2.1 %). the decline in foreign investment. The average poverty rate is still four times higher inside the country. compared to wealthier coastal regions which are richer [20].

In the other hand exportations represent 45 % of the GPD. and 81% of exportations are intended for European with 5700 industrial companies. Tunisia is the leading industrial exporter in the southern shore of the Mediterranean to the European Union (January 2008). Also. Tunisia has exceptional assets in logistic performances: It's proximity to Europe. its strategic position between North Africa. Europe and Asia.

4. Problem postulate and methodology

We can add to all those assets (cited in the last section) that Tunisia has a strategic geographic position and through this. many questions are asked about the performance of the Tunisian logistics sector (110th world class according to LPI ranking 2018 the World Bank) [20]. So. politic decision governs economic logic and therefore the location of economic activities. Hence the interest of this work which its overall aim is to define a decision support tool for location of logistic platforms in order to have an efficient logistic system. However. the use of multicriteria analysis helps in comparing actions and therefore to generate one or many proposals. In fact. through geographic information. multicriteria analysis. we select variants for satisfying preferences of decision makers. Criteria can be quantitative and qualitative. This type of criteria is suitable for the evaluation of urban projects. Thus. the choice of multicriteria methods should take in account problem nature and decision makers choices

4.1. ELECTRE III method

ELECTRE III method belongs to a family of ELECTRE methods. proposed by Roy [23] and it is based on the binary outranking relation [23. 30]. In this method. the basic set of data is composed of the following elements: a finite set of variants A. a family of criteria F. and the preferential information submitted by the DM. The preferential information is defined in the form of criteria weights - w and the indifference - q. preference - p and veto - v thresholds [23]. The thresholds define the following intervals of preference between variants on each criterion: indifference (up to q). weak preference (between q and p). (strong) preference (between p and v) and incomparability (beyond v). Variants a and b are considered indifferent if the difference between their evaluations $f(a)$ and $f(b)$ on a specific criterion is so small

(smaller than q) that the DM can't make any distinction between variants. Variant a is weakly preferred against variant b if the difference between their evaluations $f(a)$ and $f(b)$ on a specific criterion is noticeable to the DM (between q and p) but he/she is hesitant to prefer one of them. Variant a is strongly preferred against variant b if the difference between their evaluations $f(a)$ and $f(b)$ on a specific criterion is substantial to the DM (between p and v) and he/she is convinced that a is preferred to b . Variants a and b are incomparable if the difference between their evaluations $f(a)$ and $f(b)$ on a specific criterion is so large (larger than v) that the DM cannot consider them as comparable objects.

The outranking relation in the ELECTRE III method is built on the basis of the concordance and discordance tests. In the concordance test a concordance matrix (Table 5), composed of the global concordance indicators $C(a,b)$, is constructed. In the discordance test, a discordance index $d_j(a,b)$ for each criterion j is calculated. The outranking relation indicates the extent to which "a outranks b" overall. This relation is expressed by the degree of credibility $d(a,b)$, which is equivalent to the global concordance indicator $C(a,b)$ weakened by the discordance indexes $d_j(a,b)$. The values of $d(a,b)$ are from the interval $[0,1]$. Credibility $d(a,b) = 1$ if and only if the assertion

$a S b$ ("a outranks b") is well founded. $D(a,b) = 0$ if there is no argument in favor of $a S b$ (not $a S b$ – "a does not outranks b"). The definition of $d(a,b)$ results in the construction of the credibility matrix based on which the method establishes two preliminary rankings (complete preorders) using a classification algorithm (distillation procedure).

During this procedure one can obtain a descending and an ascending preorder. In the descending distillation the ranking process starts from the selection of the best variant, which is placed at the top of the ranking. In the ascending distillation the variants are ranked in the inverse order. The final ranking is generated as an intersection of the above-mentioned complete preorders. It can be presented either in the form of the ranking matrix (Table 4) (or in the form of the outranking graph. The following situations can be distinguished there: indifference (I), preference (P), lack of preference ($P\sim$) and incomparability (R).

4.2. Relevant criteria

The decision to locate logistics platforms is a complex issue, because decision depends on several factors (information, the general context and the weight of each criterion [12]). So, results should be based on studied criteria and information related to those criteria can be quantitative and qualitative. Hence the role of multicriteria analysis methods which makes these criteria conflicting, these are evaluated by the weights assigned by the decision-makers (preferences) in order to find the optimal site location or ranking.

In this context, we considered variants (described below) which have been defined as 24 governorates, distributed all over Tunisia and representing potential areas for placing the logistic platforms on their territory. We propose a set of 7 measures, denominated by C1, C2, ..., C7 that includes criteria representing different aspects of evaluation and interests of different stakeholders. All 7 criteria are presented below (year 2024).

- **C1** - Condition of transportation infrastructure – $[km/100km^2]$. This maximized criterion is defined as a density of road and rail infrastructure in the considered region. It measures logistics accessibility of the region and transportation efficiency for distributing goods. The criterion is expressed as a ratio of the overall length of public roads and standard gauge railway lines and the total area of the region.
- **C2** – socio Economic development – $[\%]$. This maximized criterion is defined as an annual value of GDP per capita in the analyzed region. It measures economic potential of a region, which is a critical factor influencing on investors' decisions concerning the placement of an investment.
- **C3** – Land price – $[TND/m^2]$. It is defined as an estimated unit purchase cost of developing 1 sq. meter of the logistic platform in the considered region.
- **C4** - Level of transportation and logistics competitiveness – $[\%]$. This minimized criterion is defined as a percentage share of logistics service providers (transportation, forwarding and warehousing companies) operating in the region in the total number of such entities in the country. The criterion is minimized to guide the DM (investor) towards the selection of less competitive environments.
- **C5** - Investment attractiveness – $[km^2]$. It is defined as a total area of all Special Economic Zones (SEZ) in the region. Thus, it helps to estimate potential benefits for the logistic platform resulting from special rules, including income tax releases, VAT reductions, reduced land use and employees' social benefits fees).
- **C6** - Transportation and logistics attractiveness – $[mln\ tonnes]$. This maximized criterion measures the industry attractiveness of each region, expressed in terms of the total annual amount of load being transported in each region by all logistics service providers. Criterion C6 is calculated as a sum of industrial products of each region.
- **C7** - Environmental-friendliness – $[m^2/habitant]$. This maximized criterion defines the environmental friendliness and the existing condition of environment in each region. It measures level of green land in each region

Table 1 Evaluation matrix for the compared variants

	C1	C2	C3	C4	C5	C6	C7
Direction of preferences	Max	Max	Min	Min	Max	Max	Max
Unit	Km/100km ²	%	Dt	%	Km ²	Mille tonnes	M ² /habitant
A1: Ariana	51.88	0.751	45	4.26	0	857.6	15.25
A2: Bizerte	55.25	0.541	45	18.18	0.81	1072.0	16.25
A3: Beja	95.62	0.354	55	20.58	0	321.6	19.56
A4: Ben Arous	77.28	0.714	65	52.65	0	1608.0	17.39
A5: Gabes	34.56	0.354	50	25.86	0	2144.0	17.40
A6: Gafsa	48.51	0.388	50	50	0	1286.4	15.74
A7: Jendouba	88.7	0.231	20	20.83	0	536.0	22.22
A8: kairouan	69.1	0.25	30	5.88	0	364.5	15.48
A9: kasserine	65.75	0.234	45	10	0	214.4	16.39
A10: Kebili	7.3	0.445	50	5.76	0	857.6	16.23
A11: Le kef	70.75	0.284	25	13.33	0.1	128.6	16.65
A12: Mahdia	56.07	0.402	52	23.07	0	536.0	17.90
A13: Manouba	125.14	0.567	70	17.64	0	643.2	15.25
A14: Medenine	60.33	0.397	50	29.62	0	214.4	16.23
A15: Monastir	120.3	0.73	30	10.9	0	2358.4	15.28
A16: Nabeul	111.23	0.615	55	22.94	0	2144.0	23
A17: Seliana	76.2	0.262	35	10.52	0	750.4	19.20
A18: Sfax	29.84	0.603	26	24.6	0	1715.2	17.52
A19: Sidi Bouzid	94.29	0.271	25	7.14	0	107.2	17.3
A20: Sousse	46.48	0.67	45	12	0	2144.0	15
A21: Tataouine	15.11	0.301	30	28.57	1.6	364.476	20.63
A22: Tozeur	18.72	0.495	25	25	0	428.8	17.20
A23: Tunis	114.3	0.762	50	21.39	0	1072.0	14.95
A24: Zaghouan	79.84	0.483	50	17.39	0	600.3	17.13



Figure 1 Potential regions (variants)

4.3. Modeling of DM’s and stakeholders’ preferences

The model of the DM’s and stakeholders’ preferences has been constructed based on interviews and surveys carried out with representatives of: investors, local residents, local companies and logistics service providers. Initially, preferences of each individual, concerning the importance of the criteria and the sensitivity of each person with respect to the changes of the criteria values, have been determined. Afterwards individual preferences and expectations have been aggregated and transferred into one, coherent model of preference, characteristic for the Electre III/IV method. This model, presented in table 2, utilizes weights of criteria - w and thresholds of indifference - q , preference - p and veto - v , to differentiate variants between each other. We don’t use the veto in our case.

Table 2 Aggregated model of preferences of the DM and stakeholders

	C1	C2	C3	C4	C5	C6	C7
w	9	8	6	7	7.5	8.5	4
q	10	0.1	5	1	0.1	100	2
p	20	0.2	10	5	0.2	500	5
v	-	-	-	-	-	-	-

4.3.1. Computational experiments

We use the ELECTRE III method to make computational experiments. whose algorithm has been presented in section 4.1. Computational experiments have been initiated by the construction of the evaluation matrix that contains data assessing all variants on all criteria (Table 1). Afterwards the aggregated model of preferences has been defined (Table 2). As a result. the concordance matrix (Table 5) composed of the global concordance indicators. has been constructed. These indicators define the degree of fulfilling the assertion that “a outrank b”. based on the arguments supporting this statement (arguments “for”). only. Thus. taking. for instance. the example of variants A3 and A5. A5 outranks A3 with a global indication $C(a, b) = 0.82$. At the same time the inverse indication that A3 outranks A5 is represented by $C(b, a) = 0.69$. These figures can be interpreted as an indication that there are slightly more arguments supporting the assertion that A5 outranks A3. Similar reasoning can be carried out for all pair-wise compared variants.

Based on the credibility matrix the method established two preliminary rankings (complete preorders) using descending and ascending distillations (Table 3). In the former the ranking is constructed from the top down to the bottom. while in the latter in the inverse sequence from the bottom up to the top. The resultant of these two distillations is the final preorder (average). In the final ranking the following situations - relations may occur: indifference - *I* - variants are indifferent and graphically placed in the same box; preference - *P* - variant *a* is preferred to *b*; *a* is placed above *b* on the graph; non-preference - *P* - variant *a* is not preferred to *b*. thus. *a* is placed below *b* on the graph; incomparability - *R* - variants are not linked (interconnected) on the graph. Using the same example of variants A3 and A5 one can see that they are incomparable. which is indicated by letter *R* in the ranking matrix.

Table 3 Ascending and descending distillation

	Ascend.	Descend.	Average	Site	Ranking
A1	4.0	7.0	5.5	A4	1.0
A2	1.0	6.0	3.5	A16	1.0
A3	2.0	3.0	2.5	A23	1.5
A4	1.0	1.0	1.0	A13	2.0
A5	1.0	6.0	3.5	A3	2.5
A6	2.0	6.0	4.0	A2	3.5
A7	2.0	5.0	3.5	A5	3.5
A8	6.0	7.0	6.5	A7	3.5
A9	6.0	7.0	6.5	A15	3.5
A10	5.0	7.0	6.0	A18	3.5
A11	5.0	7.0	6.0	A20	3.5
A12	3.0	6.0	4.5	A6	4.0
A13	1.0	3.0	2.0	A14	4.0
A14	2.0	6.0	4.0	A21	4.0
A15	1.0	6.0	3.5	A24	4.0
A16	1.0	1.0	1.0	A12	4.5
A17	3.0	6.0	4.5	A17	4.5
A18	1.0	6.0	3.5	A22	5.0
A19	4.0	7.0	5.5	A1	5.5
A20	2.0	5.0	3.5	A19	5.5
A21	1.0	7.0	4.0	A10	6.0
A22	3.0	7.0	5.0	A11	6.0

A23	1.0	2.0	1.5	A8	6.5
A24	4.0	4.0	4.0	A9	6.5

Being at the top of the ranking they become the most desirable solutions: Variants A4 and A16 represent: Ben Arous and Nabeul, respectively. They are located in the eastern north and Central-northern part of Tunisia. Based on the results generated in the ranking matrix (Table 4) one may conclude that both variants are equally good (22 indications P-preferred). A4 is characterized by high level of socio-economic development and A16 is characterized by high volume of industrial products and has the best condition of transportation infrastructure conditions. In other hand, A8 and A9 have the lowest level of socio-economic development and have not important industrial activities.

Table 4 Ranking matrix

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	
A1	0	P-	P-	P-	P-	P-	P-	P+	P+	P+	P+	P-	I	P-	P-	P-	P-	P-							
A2	P+	0	R	P-	I	P+	R	P+	P+	P+	P+	P+	P-	P+	I	P-	P+	I	P+	R	P+	P+	P+	P-	R
A3	P+	R	0	P-	R	P+	P+	P+	P+	P+	P+	P+	P-	P+	R	P-	P+	R	P+	P+	R	P+	P-	P+	
A4	P+	P+	P+	0	P+	P+	P+	P+	P+	P+	P+	P+	P+	P+	P+	I	P+	P+							
A5	P+	I	R	P-	0	P+	R	P+	P+	P+	P+	P+	P-	P+	I	P-	P+	I	P+	R	P+	P+	P-	R	
A6	P+	P-	P-	P-	P-	0	P-	P+	P+	P+	P+	P+	P-	I	P-	P-	P+	P-	P+	P-	R	P+	P-	R	
A7	P+	R	P-	P-	R	P+	0	P+	P+	P+	P+	P+	P-	P+	R	P-	P+	R	P+	I	R	P+	P-	R	
A8	P-	0	I	P-																					
A9	P-	I	0	P-																					
A10	P-	P+	P+	0	I	P-																			
A11	P-	P+	P+	I	0	P-																			
A12	P+	P-	P-	P-	P-	P-	P-	P+	P+	P+	P+	0	P-	P-	P-	P-	I	P-	P+	P-	R	P+	P-	R	
A13	P+	P+	P+	P-	P+	P+	P+	P+	P+	P+	P+	P+	0	P+	P+	P-	P+	P-	P+						
A14	P+	P-	P-	P-	P-	I	P-	P+	P+	P+	P+	P+	P-	0	P-	P-	P+	P-	P+	P-	R	P+	P-	R	
A15	P+	I	R	P-	I	P+	R	P+	P+	P+	P+	P+	P-	P+	0	P-	P+	I	P+	R	P+	P+	P-	R	
A16	P+	P+	P+	I	P+	P+	P+	P+	P+	P+	P+	P+	P+	P+	P+	0	P+	P+							
A17	P+	P-	P-	P-	P-	P-	P-	P+	P+	P+	P+	I	P-	P-	P-	P-	0	P-	P+	P-	R	P+	P-	R	
A18	P+	I	R	P-	I	P+	R	P+	P+	P+	P+	P+	P-	P+	I	P-	P+	0	P+	R	P+	P+	P-	R	
A19	I	P-	P-	P-	P-	P-	P-	P+	P+	P+	P+	P-	0	P-	P-	P-	P-	P-							
A20	P+	R	P-	P-	R	P+	I	P+	P+	P+	P+	P+	P-	P+	R	P-	P+	R	P+	0	R	P+	P-	R	
A21	P+	P-	R	P-	P-	R	R	P+	P+	P+	P+	R	P-	R	P-	P-	R	P-	P+	R	0	P+	P-	R	
A22	P+	P-	P-	P-	P-	P-	P-	P+	P+	P+	P+	P-	P+	P-	P-	0	P-	R							
A23	P+	P+	P+	P-	P+	P+	P+	P+	P+	P+	P+	P+	P+	P+	P+	P-	P+	P+	P+	P+	P+	P+	0	P+	
A24	P+	R	P-	P-	R	R	R	P+	P+	P+	P+	R	P-	R	R	P-	R	R	P+	R	R	R	P-	0	

Table 5 Concordance matrix

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24
A1	0.00	0.66	0.50	0.39	0.69	0.72	0.60	0.85	0.79	0.98	0.70	0.79	0.56	0.86	0.51	0.31	0.63	0.68	0.75	0.69	0.63	0.86	0.63	0.68
A2	0.84	0.00	0.62	0.27	0.69	0.81	0.68	0.93	0.99	1.00	0.90	0.82	0.70	0.86	0.51	0.32	0.79	0.69	0.82	0.78	0.65	0.86	0.58	0.82
A3	0.67	0.54	0.00	0.41	0.69	0.69	0.93	1.00	1.00	0.83	1.00	0.90	0.45	0.86	0.49	0.48	0.86	0.56	1.00	0.67	0.71	0.81	0.51	0.88
A4	1.00	0.85	0.85	0.00	0.83	1.00	0.90	1.00	1.00	1.00	1.00	1.00	0.82	1.00	0.65	0.57	1.00	1.00	0.87	0.83	0.82	1.00	0.82	1.00
A5	0.71	0.53	0.82	0.40	0.00	0.79	0.74	0.82	0.82	1.00	0.82	0.82	0.54	0.72	0.61	0.58	0.82	0.84	0.82	0.81	0.76	0.93	0.66	0.77
A6	0.84	0.77	0.77	0.39	0.83	0.00	0.74	0.82	0.87	1.00	0.82	1.00	0.57	0.97	0.49	0.41	0.78	0.70	0.82	0.67	0.77	0.99	0.66	0.82
A7	0.63	0.40	0.84	0.41	0.53	0.48	0.00	0.88	0.88	0.63	1.00	0.72	0.54	0.63	0.37	0.33	0.83	0.55	1.00	0.55	0.59	0.73	0.37	0.72
A8	0.55	0.26	0.50	0.41	0.56	0.51	0.58	0.00	0.77	0.56	0.86	0.62	0.32	0.66	0.35	0.15	0.71	0.53	0.81	0.41	0.63	0.70	0.23	0.51
A9	0.67	0.38	0.49	0.38	0.66	0.60	0.51	0.98	0.00	0.67	0.92	0.61	0.26	0.76	0.49	0.15	0.80	0.53	0.82	0.64	0.63	0.65	0.35	0.50
A10	0.66	0.48	0.64	0.23	0.51	0.54	0.60	0.82	0.71	0.00	0.68	0.68	0.52	0.68	0.35	0.32	0.66	0.42	0.81	0.35	0.65	0.83	0.47	0.68
A11	0.55	0.27	0.50	0.41	0.57	0.56	0.51	0.94	0.88	0.61	0.00	0.58	0.25	0.72	0.49	0.15	0.70	0.53	0.82	0.55	0.60	0.61	0.23	0.46
A12	0.75	0.62	0.82	0.23	0.77	0.69	0.76	0.95	1.00	0.91	0.92	0.00	0.59	0.86	0.49	0.41	0.77	0.65	0.82	0.67	0.69	0.97	0.49	0.82
A13	0.82	0.71	0.87	0.61	0.69	0.69	0.84	1.00	1.00	0.95	1.00	0.84	0.00	0.86	0.73	0.61	0.94	0.68	1.00	0.83	0.63	0.86	0.61	1.00
A14	0.67	0.61	0.78	0.28	0.83	0.69	0.65	0.98	1.00	0.83	0.99	0.91	0.45	0.00	0.49	0.41	0.70	0.67	0.82	0.67	0.76	0.95	0.49	0.71
A15	0.88	0.59	0.68	0.74	0.74	0.74	0.78	1.00	0.88	0.88	0.95	0.72	0.74	0.74	0.00	0.66	0.95	0.85	1.00	0.88	0.63	0.86	0.74	0.74
A16	0.94	0.85	1.00	0.74	0.93	0.86	1.00	1.00	1.00	1.00	1.00	1.00	0.81	0.86	0.93	0.00	1.00	0.98	1.00	1.00	0.71	0.96	0.92	1.00
A17	0.72	0.34	0.57	0.41	0.57	0.53	0.79	1.00	0.88	0.74	0.94	0.68	0.40	0.68	0.49	0.18	0.00	0.53	0.85	0.53	0.71	0.70	0.31	0.58
A18	0.62	0.55	0.70	0.54	0.73	0.58	0.75	0.82	0.70	0.88	0.82	0.70	0.70	0.56	0.61	0.48	0.72	0.00	0.82	0.62	0.72	1.00	0.61	0.70
A19	0.55	0.26	0.68	0.41	0.57	0.54	0.64	0.93	0.81	0.59	0.86	0.55	0.23	0.70	0.39	0.21	0.63	0.53	0.00	0.41	0.61	0.61	0.23	0.41
A20	1.00	0.71	0.49	0.55	0.85	0.86	0.60	0.82	0.83	1.00	0.81	0.79	0.56	0.79	0.77	0.48	0.76	0.85	0.81	0.00	0.63	0.85	0.68	0.68
A21	0.37	0.37	0.70	0.23	0.54	0.39	0.79	0.82	0.70	0.64	0.82	0.67	0.46	0.70	0.49	0.36	0.70	0.58	0.82	0.37	0.00	0.85	0.37	0.51
A22	0.40	0.38	0.69	0.23	0.60	0.39	0.74	0.82	0.70	0.74	0.82	0.70	0.65	0.57	0.49	0.42	0.61	0.80	0.82	0.41	0.72	0.00	0.37	0.67
A23	1.00	0.85	0.93	0.56	0.70	0.81	0.92	1.00	1.00	1.00	1.00	0.95	0.86	0.86	0.83	0.73	0.94	0.74	0.99	0.83	0.63	0.90	0.00	1.00
A24	0.77	0.69	0.81	0.41	0.69	0.69	0.83	1.00	1.00	0.93	1.00	0.86	0.70	0.86	0.49	0.38	0.98	0.66	0.92	0.69	0.67	0.86	0.40	0.00

5. Conclusion

In this paper the authors have presented the first stage of this procedure. which has involved the definition of variants and the consistent family of criteria. modelling of the DM's and stakeholders' preferences and performing a series of computational experiments resulting in generation of the final ranking of regions. The authors have proved that multiple criteria nature of the LP location problem may induce a conflict of interests between the DM and stakeholders (interveners) and an effort must be put to find a compromise solution.

The original output of this research is as follows

- Division of the logistics platform's location problem into two phases.
- Formulating the regions' evaluation problem as a multiple criteria ranking problem with the definition of an original family of evaluation criteria.
- Generating the ranking of the regions with the application of ELECTRE III method.
- Proving the applicability of ELECTRE III method to the analysis of the logistics platform's location problem.

The proposed methodology has a universal character and can be applied in selecting any location of the LP and any other elements of the logistics infrastructure. including warehouses. shopping centers. transportation hubs. After certain customization it can be also used in solving other categories of location problems.

From a practical point of view the results of this project can be summarized as follows

- The best regions for placing the platforms on their territory are regions A4. A16. A23. A13A3. A7..... The first one is more attractive from an investor point of view. due to the best condition of transportation infrastructure. socio economic development and industrial production. The second one has well developed transportation infrastructure.
- In the regions' evaluation process preferences of various stakeholders differentiate significantly. The interests of local residents focus on social. aspects. while investors. logistics operators and local companies consider primarily economic and market-oriented issues. This research should be further extended and conducted in two areas. focused on
 - Finding solutions for regional imbalance. in fact. the best locations are. always. those with high level of economic and social development
 - Formulating and solving the second sub-problem of the logistics platform's location problem. This second stage should involve the micro analysis and should be focused on selecting specific locations for the logistics platforms in the selected region.

Compliance with ethical standards

Disclosure of conflict of interest

The authors have no conflict of interest to be declared.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

- [1] Becker D. "The Development of Logistics Facilities in France and its Challenges for Development Policies." Report of the General Council of Bridges and Roads. March 2003.
- [2] Bhatnagar R. Sohal AS. Supply Chain Competitiveness: Measuring the Impact of Location Factors, Uncertainty, and Manufacturing Practices. Technovation. 2005 May 1;25(5):443-56.
- [3] Boussida S. Rabah IB. Salhine RB. Notes and Analyses of the ITCEQ.". Notes and Analyses of the ITCEQ. 2011 May.

- [4] Buck consultants international (2001).The Role of Third Party Logistics Service Providers and their Impact on Transport. Annexe2:Analyse of European logistics Regions. London and South East Region (www.logistik.tuberlin.de/protrans/p_public/p_public_files/Work_Package_2/annex%20oresund%20region.pdf).
- [5] Farahani R., SteadiSeifi M. S., Asgari N.. 2010. Multiple criteria facility location problems: A survey. *Applied Mathematical Modelling*. 34.1689-1709.
- [6] Farahani R.Z. Hekmatfar M. (Eds).. 2009. *Facility Location: Concepts, Models, Algorithms and Case Studies*. Heidelberg: Physica-Verlag.s fuzzy AHP-Vikor model. *International Journal for Traffic and Transport Engineering*. 5 (1): 54 -63
- [7] Guyon O. Absi N. Feillet D. Garaix T. A modeling approach for locating logistics platforms for fast parcels delivery in urban areas. *Procedia-Social and Behavioral Sciences*. 2012 Jan 1;39:360-8.
- [8] Hesse M. Rodrigue JP. The transport geography of logistics and freight distribution. *Journal of transport geography*. 2004 Sep 1;12(3):171-84.
- [9] Issam A. Bouzidi A. Logistics and territorial development: use of a multi-criteria decision-making model for evaluating the relevance of industrial and logistics positioning in the case of the Chaouia-Ouardigha region, Morocco. *International Journal of Innovation and Applied Studies*. 2016;14(2):526.
- [10] Joignaux G. What impact does logistics have on territorial development? SESP Summary Notes. 2008;168:45-50.
- [11] Klapita V. Švecová Z. Logistics centers location. *Transport*. 2006 Jan 1;21(1):48-52.
- [12] Lee KL. Huang WC. Teng JY. Locating the competitive relation of global logistics hub using quantitative SWOT analytical method. *Quality & Quantity*. 2009 Jan;43(1):87-107.
- [13] Lösch A. *The spatial organization of the economy*. (No Title). 1944.
- [14] Masson S. Petiot R. Territorial attractiveness. Logistics infrastructure and sustainable development. *Les Cahiers Scientifiques du Transport-Scientific Papers in Transportation*. 2012 Mar 31;61.
- [15] Mérenne-Schoumaker B. The location of large logistics zones. *Bulletin of the Geographical Society of Liège*. 2007(49).
- [16] Owen SH. Daskin MS. Strategic facility location: A review. *European journal of operational research*. 1998 Dec 16;111(3):423-47.
- [17] Özmen M. Aydoğan EK. Robust multi-criteria decision making methodology for real life logistics center location problem. *Artificial Intelligence Review*. 2020 Jan;53(1):725-51.
- [18] Perrat J. Zimmermann JB. *Firm Strategies and Territorial Dynamics*. Aix-Marseille Universities II and III; 2002.
- [19] Inter-Ministerial Center for Forecasting and Anticipating Economic Changes (PIPAME). *Samarkand (2009). Logistics in France: Territorial Indicators*. Paris. Ministry of the Economy.
- [20] World Bank Report on the LPI "Logistics Performance Index". 2018.
- [21] Regmi MB. Hanaoka S. Location Analysis of Logistics Centers in Laos. *International Journal of Logistics Research and Applications*. 2013 Jun 1;16(3):227-42.
- [22] Ren YC. Xing T. Quan Q. Zhao GQ. Fuzzy cluster analysis of regional city multi-level logistics distribution center location plan. In *Quantitative Logic and Soft Computing 2010: Volume 2* 2010 Oct 14 (pp. 499-508). Berlin. Heidelberg: Springer Berlin Heidelberg.
- [23] Roy B. The outranking approach and the foundations of ELECTRE methods. *Theory and decision*. 1991 Jul;31(1):49-73.
- [24] Rushton A. Croucher P. Baker P. *The handbook of logistics and distribution management: Understanding the supply chain*. Kogan Page Publishers; 2022 Jan 3.
- [25] Savy M. "Territory: Places of Democracy." *Hommes & Libertés*. No. 137. January–March 2007
- [26] Strale M. The location of logistics companies and the positioning of northwestern European urban regions. *Belgeo. Belgian Journal of Geography*. 2010 Sep 30(1-2):119-34.
- [27] Tomić, V.; Marinković, D.; and Marković, D. 2014. The selection of logistics centers location using multi-criteria comparison: Case study of the Balkan Peninsula. *Acta Polytechnica Hungarica*. 11(10).

- [28] Tu CS; Chang CT; Chen KK; Lu HA. Applying an AHP-QFD conceptual model and zero-one goal programming to requirement-based site selection for an airport cargo logistics center. *International Journal of Information and Management Sciences*. 2010 Jan 1;21(4):407-30.
- [29] Uysal HT. Yavuz K. Selection of logistics center location via ELECTRE method: A case study in Turkey. *International Journal of Business and Social Science*. 2014 Aug 1;5(9):276-89.
- [30] Vincke P. *Multicriteria decision-aid*. John Wiley & Sons; 1992.
- [31] Von Thünen JH. *Der insolierte staat in beziehung auf landwirtschaft und nationalökonomie*. Walter de Gruyter GmbH & Co KG; 2022 Sep 6.
- [32] Weber A. *Theory of the Location of Industries*. University of Chicago Press; 1929.
- [33] Żak J. Węgliński S. The selection of the logistics center location based on MCDM/A methodology. *Transportation Research Procedia*. 2014 Jan 1;3:555-64.
- [34] Zhang P. 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). 2024 Jul 29;3(3):103-7.