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3PL Grain Terminal Location Analysis Using Multi-Criteria Decision Making (MCDM)

by

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Abstract

Location selection cannot and should not only be based on hard data such as quantifiable numbers. There are so many environmental related factors which directly affect a location, corporations and supply chains which need to be considered when deciding on future locations. Such decisions are strategic in nature and since the location is expected to operate over an extended amount of time, it cannot just be economically moved or disposed of. This thesis reviews the different contributions with respect to location analysis, multi-criteria analysis, Multinational Enterprise (MNE) expansion strategies, the North American grain market, its supply chain and particularities. The purpose is to use this knowledge in order to help us determine where to locate a 3PL grain terminal in the U.S. This will be applied to a real life problem for Ray-Mont Logistics (3PL) as it wishes to locate its first terminal in the U.S. but is not sure where to locate it. An in depth case study of 5 different ports will be evaluated with the use of Analytic Hierarchy Process (AHP), a multi-criteria analysis technique which encompasses qualitative and quantitative criteria in order to find the best location of a potential US 3PL grain terminal. This thesis will bring a fresh new addition in regards to the location of grain terminals which has scarcely been studied by modern science and has never been analyzed under the scope of multiple dimensions such as: operational research, economics and logistics.

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Introduction

The purpose of this thesis is to locate a grain transloading terminal in the United States for Ray-Mont Logistics Inc. The company is a well-established grain transloader and freight forwarder in Canada and wishes to expand its operations south of the border but is not sure where and how to decide on the optimal location. An extensive literature review was developed and broken down into four distinct sections in order to properly contextualize the reader in regards to this specific location problem, more particularly on how corporations locate facilities. The sections cover the historical review of the location problem, the operational theories on location decisions, the economics and location theory which leads to foreign direct investments and a new concept known as logistics clusters. The final objective of the thesis is to locate the best city in which to build a grain transloading terminal. The research question is: How can Multi-Criteria Decision Making (MCDM) be used in order to determine the best location for a 3PL grain terminal in the United States? In order to select the best location with a discrete number of possible locations, multi-criteria analysis and more precisely analytic hierarchy process (AHP) technique will be used to rank locations based on a subset of six location factors, twenty-one criteria and five alternatives with the use of an expert panel. The expert panel is composed of Ray-Mont Logistics board of directors and upper management. Their role is to rank location factors, criteria and alternatives with the use of pairwise comparisons as well as quantitative data in order to find the best location to build a terminal in the United Sates.

Mainstream location analysis techniques rely on the use of origin and destination points with pre-determined demand and costs moving on the arcs between these points. In the case of Ray-Mont Logistics, there is an inland transport arc between the supplier and the potential terminal location as well as another export arc between the terminal and the end client located on another continent. This type of technique will not be used as the inland transport costs often vary between suppliers and a potential terminal, and because some port locations optimally service certain continents more effectively. Rail companies tend to change the pricing structure depending on congestion in a certain port due to high volumes of full and empty equipement such as railcars and intermodal units or the need to serve new markets. Ocean carriers also modulate pricing in regards to the port location of excess empty containers, port vessel maximisation and the need to serve new markets. Furthermore, end customer demands also vary from year to year depending on the price of grain sourced from other competing countries. Because of all these variables, the supply chain is often reshaping itself as costs and demands will continuously vary on the inland and the export arcs. In order to deal with this uncertainty, we will apply the AHP technique which uses tacit knowledge from the expert panel in order to rank criteria and alternatives of the possible terminal locations with the use of soft, hard and subjective data.

1. Literature Review

Facility location is one of the most critical and strategic aspects of public and private firms. Trying to locate a fire station, warehouse, ambulance or a mall as an example, is a challenge for planners as environments are dynamic as they change over time making the perfect location today a nightmare tomorrow. In most cases the location of a new facility requires a considerable monetary investment as it is a durable asset and requires a specific return on investment or service allocation over a set period of time. When trying to determine the optimal location, a decision maker cannot base his decision solely on quantitative data. He needs to incorporate qualitative data also to support his decision making process in order to make an informed decision. Modeling this type of problem is a complex task and it requires good judgement as once the facility in located, it can"t be economically moved or disposed of if an error in judgement was to occur. Determining the best location of a facility is thus a strategic challenge for corporations and governmental agencies.

In order to properly explain the problem in respect to the literature, this section will be broken-up into three dimensions. Each dimension will cover an area which is considered specific to the problem but will be joined together in the methodology section. The dimensions are Operational Research, Economics and Logistics. The first dimension will look into the details of the problem mathematically and how others have resolved location problems. The second dimensions will look at the soft criteria which are qualitative in nature and will attempt to bring forth the main factors which a Multinational Entreprise (MNE) looks at when expanding into a new location. Lastly, the third dimension will look at a new phenomenon known as a logistics clusters, its specificities and importance in respect to the location problem.

1.1 Historical brief review of the location problem

The location problem has probably existed since the birth of mankind. The scientific community traced location analysis back to the early 1600"s as Pierre de Fermat, Evangelista Torricelli and Battista Cavalieri drew-up the first sketches of what was to become a mathematical science of where to locate. There is still debate of who of the three first came up with the concept (Wesolowski 1993). Following in their footsteps, the German economist Johann-Heinrich von Thünen (1826) was one of the first to focalise on the location of economic activities of cities and farms, balancing both

transport and land costs in order to produce the most efficient product to the market. Thus, the further away a farmer locates from the city center, the more expensive transport costs are to bring goods to the city center. Based on this understanding, a farmer located at a certain distance from the market will want to maximise his profits by growing the products that generate, at that distance, the highest profits. Von Thünen"s model is based on concentric rings of agricultural output developing around a city. Production of perishable goods or goods needing quick market access locates in the nearest rings to the city whereas activities such as livestock farming would take place on the farthest rings. It is important to note that his assumptions were based on linear transport costs. Not too long after von Thünen"s model came the Weber problem brought forth by Alfred Weber in 1909. Weber developed the solution of where to place an industrial location which minimized transport costs between three fixed points on a plane which represented two material sources and a place of consumption such as a market. The location of a central point (spatial median) was considered as the optimum location for the factory. He solved the problem with the use of different weights at each point. The weights are considered as a demand at a certain point which pull the central point on the X and Y axis in order to locate the optimum. The Weber problem is the base of location analysis and has since seen many extensions and models (Drezner and Hamacher, 2002). Weber viewed the location problem in a comparable way to von Thünen"s concept except for one big difference. Whereas von Thünen viewed demand as being centrally located and supply to be spatially distributed, Weber considered production as centrally located and demand to be spatially distributed (Nicholson 1976). Renewed interest only came in 1964 with a publication from S.L. Hakimi who was trying to locate switching centers in a communications network and police stations in a highway system (Hesse Owen and Daskin 1998). Unlike Weber, who was locating only one facility, Hakimi was attempting to locate one or more facilities on a network in order to minimise the total distance between clients and the closest facility. In other words his objective was to minimise the maximum distance between the farthest clients and a set of possible facilities.

Weber also brought forth the concept of agglomerative factors where producers would locate at close proximity of each other. He defined an agglomerative factor as: “an advantage or a cheapening of production or marketing which results from the fact that production is carried on to some considerable extent at one place, while a deglomerative factor is cheapening of production which results from the decentralization of production (production in more than one place)” (Friedrich 1929). Weber analyzed agglomeration factors in terms of labor and transportation whereas modern location analysis is confronted with the same analysis where it has to quantify and qualify these factors. This is quite interesting as agglomerative factors have become overly important

100 years later when trying to locate facilities. This brings us to the importance of logistics clusters which will be brought forth later into the literature review.

The next sections will cover the Operational Research, Economics and Logistics dimensions and go into more detail on the location analysis concept

1.2 Operational Research theories on location decisions

Since Hakimi"s extension of the Weber problem in 1964, the study of the location theory has flourished (Hesse Owen and Daskin 1998). In fact, there has been a plethora of articles and advances in problem formulations since this point in time and it marks a starting point for modern location analysis.

What is exactly the definition of location analysis with an operations research dimension? ReVelle and Eiselt (2003 : 1) define the term location analysis as: *"the modeling, formulation, and solution of a class of problems that can best be described as sitting facilities in some given space"* and distinguishes between location and layout problems. The former having small facilities in relation to space with or without interaction between the facilities, whereas the latter has large facilities in respect to a given space. Others such as Farahani et al. (2010 : 1690) characterize it as: "*… locating or positioning at least a new facility among several existing facilities in order to (minimise or maximise) at least one objective function (like cost, profit, revenue, travel distance, service, waiting time, coverage and market share)*". Furthermore, location problems are characterized by four different components which are essential to their resolution and analysis. The first being customers located at points or on a route, the second are facilities which need to be located, the third is a space in which customers and facilities are located and lastly a metric that indicates distances or times between customers and facilities (ReVelle and Eiselt, 2003). Francis et al. (1983) add that location analysis models consist in locating one or more facilities, and may include transport costs, fixed costs, constraints on the number of new facilities, upper bounds on the distances between existing and new facilities as well as varying demands between the existing and new facilities. In fact there is a very large amount of variables that can be factored in a location problem as well as many different ways of solving its optimisation.

According to Chhajed et al. (1993), location problems can be classified into different categories such as: planar, discrete, and network models. Their differences are mainly in the way the distance between any two points is defined. In fact any given location problem can be solved in any of these three classifications. There are other problem classifications such as the warehousing model discussed by Francis et al (1983). Many extensions of these models can be found also under the following classification: median, center, covering, dynamic location, stochastic location and scenario planning models, (see: Hesse Owen and Daskin 1998), mixed integer programming (single product, multiple product, dynamic, probabilistic, hub locations routing and multi-objective models), (see: Klose and Drexl 2003) to just name a few. What separates all these problems apart is the objective of the decision maker, the number of locations he is trying to locate, the type of category and the demand of the particular locations. Hence, there are many types of objectives such as profit maximisation or alternatively cost minimisation which are recurrent when optimizing for firms. One can also have an objective to minimise the maximum distance separating a client from a location such as an ambulance station. These last two types are known as "Pull" objectives and also known as minisum or minimax. In contrast there are also objectives known as "Push" where the decision maker will want to push away the facility as far as possible from its customers. Such facilities are known as noxious or obnoxious and tend to locate towards infinity. ReVelle and Eiselt (2003 : 4) give an interesting example of such obnoxious facilities and their conflicting objectives: *"…the location of a sanitary landfill, a facility most people would consider undesirable. The customers of the landfill and the general population would prefer to push the landfill as much away from them as possible, while, in an attempt to minimize costs, the company in charge of the garbage collection will attempt to locate as close to those who generate the garbage as possible. (A closer examination will, of course, reveal that, since the public is ultimately paying for the service, one of the public's objectives is also of the "pull type".) Any solution to the problem will ultimately require explicit or implicit information about the tradeoffs of the objectives involved".* There is another type of objective known as "equity" where the idea is to make the facilities equally accessible to all potential clients. These can be adapted to push and pull objectives. Lastly, location problems can also be divided into private and public sector objectives. The private sector generally tends to locate plants or warehouses with respect to a monetary value in function of a given location (ReVelle and Eiselt 2003). Such models refer to the aforementioned pull factors where the decision maker is looking at maximising profits or minimising costs. On the other hand public sector problems are more inclined in maximising the overall welfare of a given population by minimizing distances and/or response time between a service and a client. Police stations, hospitals, ambulances and fire stations are some clear examples. ReVelle and Eiselt (2003) revealed that defining objectives in the public sector is much more complicated than in the private sector because public sector

objectives are less tangible and are a matter of opinion since the decision maker can minimise the average distance or minimise the longest distance. Each of these last two objectives can yield a very different solution.

In the next section we will discuss and characterize the planar, discrete and multi-objective/multi-criteria models, explaining their advantages, disadvantages and utilities. The network model is left out as it defeats the purpose of this exercise as they can be modeled as planar and discrete models. Furthermore, we will not discuss the demand types (static, dynamic, elastic and stochastic) nor the context (monopoly and perfect competition) for the same reason listed above, it would make the exercise interminable and would take us out of scope. However, demand types and context are very important to consider when selecting and modeling a location problem and should not be overlooked.

1.2.1 Planar models

Planar models as their name implies aim to locate one or more facilities on a plane where the possible locations of facilities are infinite. Such models typically include Euclidean distances (birds eye view) and costs or distances are applied between the existing and new facilities with known planar locations (Francis et al. 1983). The objective is to minimise costs or distances. These types of problems are generally used for their insight versus their accuracy. One of the key problems with them is that Euclidean distances are not very realistic as road networks are not known to be straight between two points. In contrast, the use of a rectilinear distance or one in between the two is generally more appropriate but makes the problem more stringent. Furthermore, the model suggests that the locations of facilities are infinite whereas it isn"t necessarily feasible to locate a processing plant in the middle of a lake. Also important to note that the model assumes that travel cost is proportional to distance which ignores economies of scale and that fixed location costs are not taken into account. After reading this, one might conclude that planar models are useless. All the contrary, planar models are simple to use, construct and understand versus a very complex problem which could take a long time to construct because of all the data required as well as the costs associated. Due to its simplicity, it can also give its user quick qualitative insights which would be consistent with their own experience if the user has little knowledge of the theory behind the various possible models (Francis et al. 1983).

Planar models are solved in three different ways and are known as minisum or minimax. The first minisum problem also known as the Weber problem consists of a plane formed by *m* demand points where v_i represents the demand or the weight at the point *i.* Distance is generally considered to be Euclidian and total transport cost between the point *i* and the facility one is trying to locate is proportional to the demand v_i and the distance d_i separating point *i* to the facility. The objective then is to find the point or location that minimises total cost in respect to the demand. Important to note that this problem cannot be solved optimally with the use of a formula (Cordeau 2012). Instead, to solve the problem, the mathematician Endre Vazonyi Weiszfeld proposed an algorithm in 1937 which by iteration can find a solution close to the optimum (Wesolowski 1993). The idea is to keep running iterations till the change in values of $\overline{X}$ and $\overline{Y}$ become negligible. $\overline{X}$ and $\overline{Y}$ are the approximate location points on a plane.

Weiszfeld algorithm

$$\overline{X} = \frac{\sum_k v_k X_k / d_k}{\sum_k v_k / d_k} \qquad \overline{Y} = \frac{\sum_k v_k Y_k / d_k}{\sum_k v_k / d_k}$$

The second minisum problem is an extension of the general Weber problem which consists of locating *p* facilities on a plane and allocating customers to those facilities. It is solved with the use of heuristics and is also known as a median problem. ReVelle and Eiselt (2003) distinguish between customer choice and allocating models where, in the former, the customers decide which facility to prioritize such as the retail sector and in the latter where, the facility planner decides which facility supplies a given customer. In both models it is quite natural that both the facilities and the customers tend to allocate to each other in terms of proximity. However, ReVelle and Eiselt (2003), point out that in customer choice models, these assumptions only make sense if customers engage in separate trips to the facility, that the facility"s characteristics such as waiting times are the same and that customers are rational planners in terms of only factoring in transportation costs which are proportional to the distance between the facility and the customer.

The third planar model is known as a minimax or covering problem. When trying to locate facilities that need to offer a rapid response or a certain level of service such as ambulances, the minisum problem isn"t appropriate. Because of the critical nature of such a service, a pre-established acceptable maximum distance between the client and the facility will be required. This type of problem is solved geometrically with the use of drawing a circle, diamond or square depending on the norm used and fitting all demand points inside or on the edge of the geometric shapes. Without going into too much detail on how to apply the method this type of problem is of greater concern for worst case situations rather than average cases. Francis et al. (1983: 227) made a great analogy of the differences between the minisum and minimax problem: "*Anyone with an insurance policy should be able to convince himself it will be the case – in the long run – that he will pay more for the policy than he will receive as benefits. Hence he would be better off, adopting a minimum total cost approach, not to buy insurance. In spite of this fact, people who can afford to do buy insurance, suggesting they are much more concerned about the worst case than about their long run expected net benefits. Similarly, with minimax location problems, we must be more concerned about the worst case than about the expected total cost, and thus find a minimax approach advocated for locating such things as fire extinguishers, fire stations, and various emergency service facilities, such as a helicopter service to respond to automobile accidents*".

1.2.2 Discrete models

With discrete models, the number of locations is finite. This particularity limits the facility placement options and facilities can now only be located at preselected sites whereas finding the best location. This is one of the major distinctions between a planar and discrete problem. ReVelle and Eiselt (2003) cite examples such as the positioning of transmitter stations that need to be placed at some permissible points within a region such as mountaintops or locating retail facilities that that can only be sited on lots that are zoned for them. Also, when trying to locate multiple facilities, in the planar model, the number of facilities and the customers they will serve are known. In the discrete model the assignement of clients to facilities become the decision variables. Therefore, costs in planar models are associated with the facilities and not the locations and their cost functions don"t necessarily include fixed costs. Discrete models on the other hand do not carry the limitations of planar models and permit the input of more realism into the problem. If we take a warehouse as an example, its implementation is highly asset specific and involves a significant amount of fixed costs which isn"t directly proportional to its output. The decision maker can model multiple decision variables such as considering fixed costs, transportation costs, operation costs, size of facilities, amount of facilities to open and capacities of facilities in order to find the most economical balance between fixed and variable costs (Francis et al. 1983). The authors mention that on one hand discrete models are more realistic; on the other hand they force the modeller to estimate multiple parameters which can throw off the solution. Furthermore, distances can be calculated in multiple ways without being subject to a specific norm as long as the same method is used to calculate the distance between each pair of points (Cordeau 2012).

The discrete models are solved with the use of integer programming, combinatorial optimization (branch and bound method) and/or heuristics. However, heuristics have been known to yield non optimum solutions and are generally used to speed up the problem resolution. ReVelle and Eiselt (2003) also add that there are countless hybrid model resolutions that do not fall under the above mentioned categories. Discrete models also use binary variables to assign demand points and to select or drop a location. As with planar models, the same type of problems are to be solved such as minisum (median) problem where the objective is to minimise the location"s fixed costs while assigning demand costs, covering problem where the objective is to cover the maximum demand points with the selected facilities in conjunction with fixed costs (retail stores) and minimax where the objective is to minimise the farthest demand points by the facilities.

1.2.3 Multi-Criteria Models

Location selection cannot and shouldn"t only be based on hard data such as quantifiable numbers. There are so many environmental related factors which directly affect a location, corporations and supply chains which need to be considered when deciding on future locations. Such decisions are strategic in nature and since the location is expected to operate over an extended amount of time, it cannot just be economically moved or disposed of. Furthermore, part of the planning process of supply chains aims at finding the best possible configuration; in addition to the generic facility location analysis, other areas such as procurement, production, inventory, distribution and routing have to be considered whereas researchers historically have focused on the design and distribution systems without considering the supply chain as a whole (Melo et al. 2009). Multi-Criteria models help in the analysis and selection of the best possible(s) location(s) by combining hard data and soft data in conjunction with mathematical models whereas, the use of hard data alone wouldn"t take into account very important criteria of certain locations.

Farahani et al. (2010) list a summary of location factors taken from an extensive literature review and explain the criteria which are used to formulate objectives (ref p. 1703). We have retained the most relevant categories with respect to this thesis" subject and reformulated them.

- Cost: This type can be divided into fixed and variable categories. Fixed costs include installation, land and start-up costs, along with all investments. Variable costs can be transportation, wages, operations, production, services, distribution, logistics, waste disposal, maintenance, and environmental costs. Several problems have used „total cost" criterion which contains all costs under one objective.

- Environmental risks: This criterion includes transportation risks, natural risks, waste disposal or treatment risks, or general „undesirable effects".

- Coverage: In terms of distance, time, amount or deviation.

- Service level: In terms of cost efficiency and lead time

- Profit: In terms of net profits but there can be other generalizations.

- Economy: labor availability, job opportunities, currency value, business climate, etc.

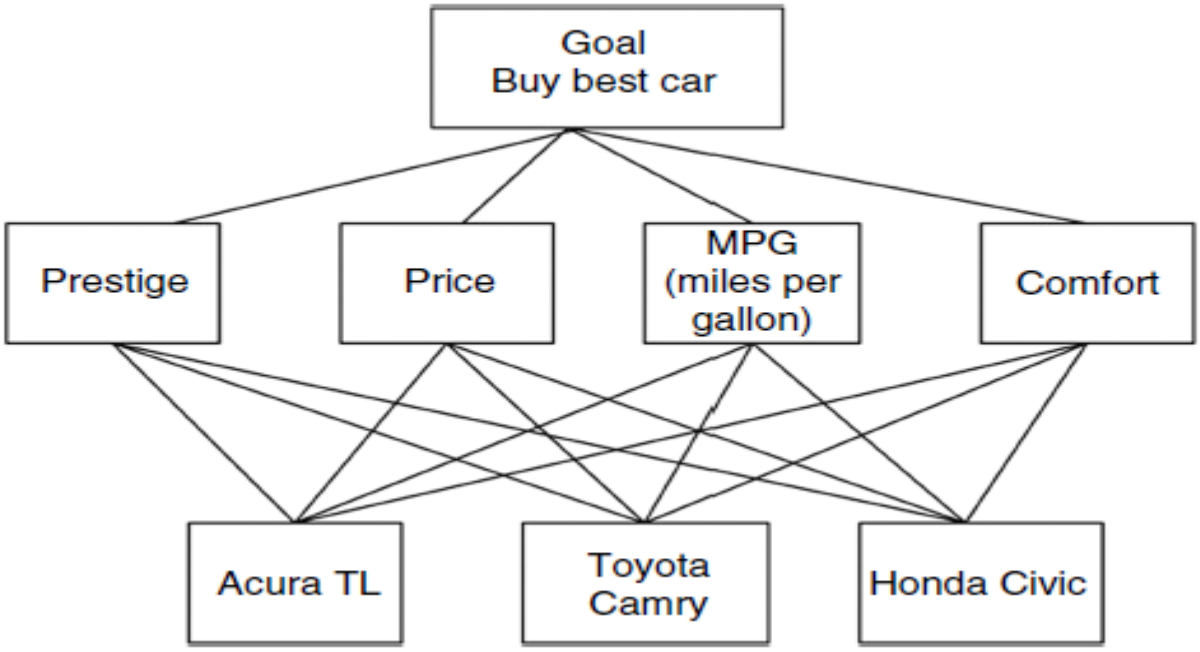
- Other criteria: Can include resource accessibility, social and political risks, governmental regulations and incentives, accessibility to railway and motorways, closeness to markets and customers, suppliers and resources.

When the decision maker is looking to pursue more than one decision factor, he is transforming the problem into a multi-objective or multi-attribute problem which all fall under the category of multi-criteria decision making problems. Multi-attribute problems are generally limited to a predetermined set of alternatives which satisfy each objective in a specified level and the decision maker selects the best solution(s) among all alternatives according to the priority of each objective and the interaction between them. The most popular techniques for problem modeling resolution are according to (Farahani et al. 2010 : 1690): “dominant, maximin, maximax, conjunctive method, disjunctive method, lexicographic method, elimination by aspects, permutation method, linear assignment method, simple additive weighting (SAW), hierarchical additive weighing, elimination and choice expressing reality (ELECTRE), technique for order preference by similarity to ideal solution (TOPSIS), hierarchical trade-offs, linear programming techniques for multidimensional analysis of preference (LINMAP), interactive SAW method and MDS with the ideal point”. On the other hand, multi-objective problems differ from multi-attribute problems as the decision maker is trying to design the best alternative by considering the various interactions within the design constraints and which are judged satisfactory by attaining an acceptable level in respect to the problems objectives. Multiple-objective problems share the following objectives: a set of quantifiable objectives, a set of well-defined constraints and a process of obtaining some trade-off information. The most popular techniques for solving multiple-objective problems are according to (Farahani et al. 2010 : 1690-1691): “global criterion method, utility function, metric L-P methods, bounded objective method, lexicographic method, goal programming (GP), goal attainment method, method of Geoffrion, interactive GP, surrogate worth trade-off, method of satisfactory goals, method of Zionts-Wallenius, the methods as step method (SETM) and related method, sequential multi-objective problem solving (SEMOPS) and sequential information generator for multi-objective problems (SIGMOP) method, method of displaced ideal, goal programming STEM (GPSTEM), method of Steuer, parametric method, C-constraint method and adaptive search method”. With multi-objective problems, the decision maker has to take into consideration that there might be conflicting objectives, that the efficient solution is one where no one objective can be improved in detriment to other objectives and that a preferred solution (which is also efficient) can be selected with the additional use of sensibility analysis. Furthermore, It is however important to take close consideration on how to factor and handle the soft criteria. Klose and Drexl (2005)

explain that multiple objectives may be handled by using cost minimisation as a primary goal and modeling other objectives as soft constraints; however while generating alternate solutions with the means of relaxing constraints, changing the objective function"s cœfficients or adding additional costs of opening and closing facilities do not guarantee Pareto-optimal solutions. Other authors such as ReVelle (1993) and ReVelle and Laporte (1996), propose an objective weighting technique which preserves the integer problem structure and may often be employed with success. Melo et al. (2009) extensive research on supply chains revealed that a vast majority of the literature deals with single-period deterministic models whereas stochasticity is still scarcely discussed and uncertainty is one of the most challenging and important problems in supply chains. Such sources of uncertainty come from customer demands, exchange rates, travel times, supply lead times, transportation and holding costs. The authors also add that financial factors have a strong impact on the supply chains and have broken it up in three categories. These factors will also be further explored in the Economics section. The first category, international factors, is composed of taxes, duties, tariffs, exchange rates, transfer prices, and local content rules. The second category is comprised of financing and taxation incentives offered by governments to attract investments in certain countries or regions. Lastly, the third category refers to facility budget limitations. Whereas most problems in the literature are focused at minimizing costs, firms are known to be profit maximizers" and problem modellers can shift the objective to maximizing the profits by subtracting costs from revenues or with post-tax profits. In some cases, this technique will reveal that servicing certain clients is not profitable and will offer a better location analysis comparison when looking at return rate of a location"s fixed assets.

In regards to multi-attribute problems, one technique that stands out is analytic hierarchy process (AHP). It was introduced by Thomas L. Saaty in the 1970"s and is based on three principles: decomposition, establishment of priorities and logical consistency (Fernandez and Ruiz, 2008). It has also been extensively used in the literature to evaluate suitable locations and transportation routes to facilities (Tuzkaya et al., 2007). The first principle of AHP is to decompose the problem in a hierarchical structure (see Figure 1). At the top of the hierarchy is the final objective of the decision problem (Ex: Buy best car). The intermediary steps contain the soft and hard criteria that affect and determine the final objective (Ex: Prestige, Price, MPG, and Comfort). Note that the intermediary steps can have sub categories. The last level of the hierarchy represents the possible solution alternatives (Ex: Acura TL, Toyota Camry, and Honda Civic).

Figure 1 AHP Hierarchical Structure



Source: Saaty (2013:1107)

In the second principle of the AHP, establishment of priorities, the decision maker begins the prioritization of the criteria with the use of pairwise comparisons. Each criterion is compared with the others on a scale of 1 to 9 (see Table 1) to determine the most desirable from the least desirable in order develop the matrix which will generate the weights.

Table 1 Pairwise Comparison Scale

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another.
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another.
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance is demonstrated in practice.
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
1.1–1.9	When activities are very close a decimal is added to 1 to show their difference as appropriate.	A better alternative way to assigning the small decimals is to compare two close activities with other widely contrasting ones, favoring the larger one a little over the smaller one when using the 1–9 values.
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	This is logical assumption.
Measurements from ratio scales		When it is desired to use such numbers in physical applications; alternatively, often one estimates the ratios of such magnitudes by using judgment.

Source: Saaty (2013: 1103)

Once the weights have been generated, each criterion will be paired against the alternative solutions in another set of matrices where normalization of the weights will take place in order to compare the criterion on the same relative scale and an optimal solution will get selected. An in depth explanation of the AHP mechanism and its variances can be found in: (Fernandez and Ruiz 2008), (Chan and Chung 2002), (Saaty 2013), (Saaty 1990), (Tzeng et al. 2002), (Guh et al. 2009).

One of the useful features of AHP is the weighting of the attributes which can be declared by users and determining which factor outweighs the others with the use of human knowledge and experience directly imputed into problem resolution (Chan and Chung 2002). The decision makers who are at the base of the weighting system can be of multiple sources and backgrounds such as scholars, key corporate personnel, specialists, consultants, etc. The pairwise weighing technique is by far superior to simply giving a weight to each criterion independently as it enables decision makers to specifically compare criterion A to B and C and then specifically compare criterion B to C which is more accurate as opposed to simply giving a weight to each criterion independently. Saaty (1990: 12) adds: "*the most effective way to concentrate judgement is to take a pair of elements and compare them on a single property without concern of*

other properties or other elements. This is why paired comparisons in combination with the hierarchical structure are so useful in deriving measurement. We also note that sometimes comparisons are made on the basis of standards established in memory through experience or training". The AHP technique is also a great tool as it offers a new way to integrate hard data with subjective judgements about intangible factors, incorporate judgments of several people and resolve conflicts among them, perform sensitivity analysis and revision at low cost, use marginal as well as average priorities to guide allocation, enhance the capacity of management to make trade-offs explicitly, a technique for selecting projects or activities, an alternative for projecting the future and protecting against risk and uncertainty, and a vehicle for monitoring and guiding organizational performance toward a dynamic set of goals (Saaty 2013).

Tzeng et al (2002) have used AHP to locate a restaurant in Taipei with the use of five objectives (economic, transportation, competition, commercial area and environment) and eleven criteria (rent cost, transportation cost, convenience of mass transportation system, parking capacity, pedestrian volume, number of competitors, intensity of competition, size of commercial area, extent of public facilities, convenience of garbage disposal, sewage capacity). They have established the weights with the use of fifteen evaluators which included five scholars, five catering experts and five restaurateurs. In addition to the use of the AHP technique, a compromise ranking method named VIKOR was used to determine weight stability intervals in order to generate a compromise solution. Fernandez and Ruiz (2008) have also used AHP to locate an industrial park in a sustainable way with the use of a multi-level hierarchical process in which each level has its own geographical decision criteria in order to have a different scale of application. The decision makers broke down the problem into 3 phases such as geographic area selection, evaluation and selection of suitable areas and evaluation of specific areas. Each phase was made up of a different set of criteria and sub-criteria in order to properly bring forth the relevant factors that compose the criteria. In all, there is a plethora of ways to use AHP and break down problems in their most relevant and descriptive attributes. Decision makers can solve complex problems with multiple tangible and intangible attributes in an organized, concise, accurate and relative way, without sacrificing objectivity in the proposed solutions. Furthermore, Saaty (2013) adds that AHP is simple in construct, adaptable to both groups and individuals, natural in terms of intuition and general thinking, encourages compromise and consensus building, and does not require inordinate specialization to master and communicate.

1.3 Economics and the location theory leading to foreign direct investment of firms

Location Theory addresses the important questions of who produces what goods or services in which locations and why. As many government policies attempt to shift production from one site to another, one must examine the basis for the initial location decisions in order to understand the impact of altering incentives (Feinberg 2009). Since the early days of location theory from Pierre de Fermat, Johann-Heinrich von Thünen and Alfred Weber, the landscape has morphed into sophisticated theories and realities to explain the reasons of why and how firms locate. This is mainly because firms and markets now compete globally. As Feinberg (2009: 739) explains: “many of the questions addressed in location theory are highly relevant to international economics. For example, trade theory explains patterns of international production and trade. Similarly, much of the research on foreign direct investment (FDI) looks at where multinational firms locate various activities. Policy applications of location theory have examined ways in which different countries, states, and regions can actively compete to be production locations for both trade and FDI”.

In order to explain the importance of economics in regards to factor conditions that lead to location decisions of MNE"s, we have broken down this section into four distinct subsections which relate to specific theories and concepts. The subsections are the comparative advantage, the competitive advantage, the eclectic OLI paradigm and the financial and political factors.

1.3.1 The Comparative Advantage

The literature on international trade and policy is quite vast and enumerates an extensive list of the reasons a country has an advantage in exporting a good over another country. Dev Gupta (2009) broke it down into the following four categories and based his arguments on the theory of comparative advantages of nations:

1- Technological Superiority: Based on Adam Smith"s principle of absolute advantage and David Ricardo"s principle of comparative advantage whereas the former refers to a country having a higher (absolute) productivity or lower cost in producing a good compared to another. In contrast, a country experiencing an absolute disadvantage can experience a comparative advantage in regards to the same commodity by trading with other countries if it has a higher relative productivity or lower costs which enables it to engage in trade even if it does not detain an absolute advantage.

2- Resource Endowments: Countries that possess abundant resources will have a comparative advantage over others even without the use of superior technologies as long as it uses the relative abundant resource more intensively than its counterpart. If we take for example 2 commodities, textiles and newsprint. Newsprint uses trees more intensively whereas textiles uses labor more abundantly compared to newsprint. If country “X” has an abundant supply of trees in regards to country “Y” and country “Y” has an abundant supply of labor, it will imply that country “X” has a comparative advantage over country “Y” for newsprint and vice versa for textiles. It is important to note that labor should be considered in terms of quantity but also in terms of skill level which is related to the role of institutions who provide the infrastructure and education to the labor force.

3- Demand patterns: Products are generally produced and introduced into the firms" local markets in order to create demand, test them, implement the production process and adjust for preferences. When looking at the product life cycle hypothesis, these products are then exported and as the product becomes standardized, production shifts to low cost countries in order to benefit from economies of scale but the home country loses its comparative advantage.

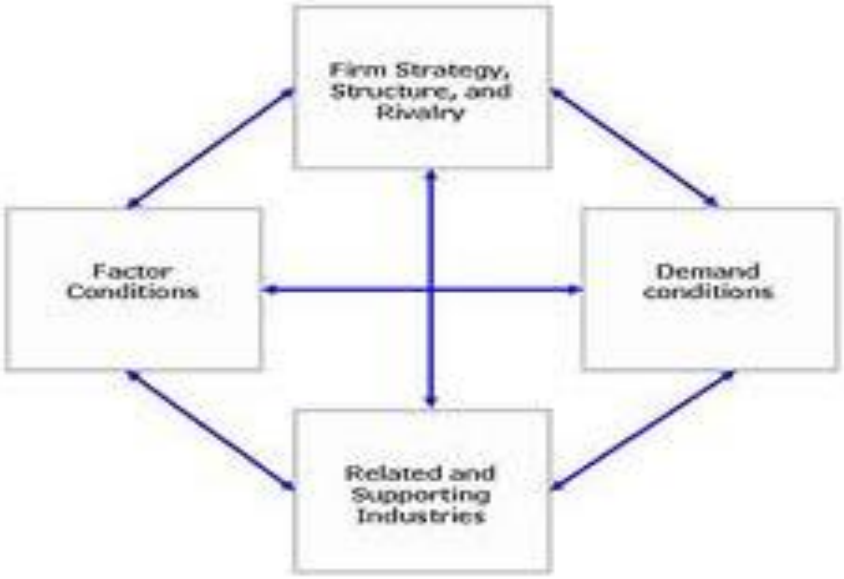
4- Commercial policies: In order to protect its comparative advantage, a country will use its institutions to regulate its infrastructure, exports, education, training, R&D policy, subsidies, taxes, restricted tendering, anti-trust policy, etc. In order to protect its trades it will place import tariffs, quotas and/or import licences, restrain exports, create local content rules, restrict outsourcing, etc., in order to provide an advantage to the domestic markets.

1.3.2 The Competitive Advantage

The comparative advantages of a country will generally dictate which industries a country will specialize in, to allocate resources, investments, develop trade policies, develop markets and supporting industries and gain know-how as well as advancements in its technologies. However, for nations to gain comparative advantages, they need firms to support them which brings us to the concept of competitive advantages developed by Porter (1990). According to Porter (1990), a nation has a competitive advantage in a given industry if it"s compared to the best in

class worldwide competitors and if it"s benchmarked to its competitors in terms of exports and outbound FDI"s based on skills assets created in the home country. Furthermore, the author"s central theme focalises on saying that “National prosperity is created, not inherited. It does not grow out of a country"s natural endowments, its labor pool, its interest rates, or its currency"s value as classical economy insists. A nation"s competitiveness depends on the capacity of its industry to innovate and upgrade. Companies gain advantage against the world"s best competitors because of pressure and challenge. …having strong domestic rivals, aggressive home-based suppliers, and demanding local customers”. Innovation is the key to success for firms who embrace it and thus gives not only the firms a competitive advantage but also the industry as a whole. His theory is based of four key determinants depicted by figure 2: factor conditions, demand conditions, related and supporting industries and firm strategy, structure and rivalry.

Figure 2 Porter Diamond Model



Source: Porter (1990 : 77)

1- Factor Conditions: Porter (1990) isn"t referring to basic factors such as labor, raw-materials, land and capital but at highly skilled human resources, scientific institutions, advanced infrastructures, etc., in order to foster innovation. His arguments are based on the fact that competitive advantages are not based from ample supplies of cheap raw materials, or abundant labor as this leads to inefficient use of resources but rather when firms are at a disadvantage when faced with high land costs, labor shortages, or a lack of raw materials.

2- Demand Conditions: Porter (1990) isn"t referring to the size of the home demand but to the composition and the character of the home market where a competitive advantage is gained when industries are able to interpret emerging buyer needs where the demanding buyers put pressure on firms to innovate faster compared to their competitors abroad.

3- Related and Supporting Industries: Porter (1990) is referring to the presence of related or supporting industries that are internationally competitive such as firms who deliver the most cost-effective inputs in an efficient, early, rapid and preferential way. An example of this is co-location of firms such as in clusters where there is a fast communication line, a flow of information and exchanges of ideas and innovations.

4- Firm Strategy, Structure and Rivalry: Porter (1990) is referring to how companies are created, organized, managed and the level of rivalry between the firms in

their domestic market. The presence of local and strong rivals is an important factor as it forces firms to gain more sustainable advantages by being more efficient and innovative.

At the base of the four key determinants are the competitiveness of firms in their home base markets and the achievement of a competitive advantage is obtained by the firms and industry"s ability to innovate. A static view of this notion is that firms in a given nation will develop a competitive advantage if those firms specialize in the production of products or services where the nation has a comparative advantage.

1.3.3 The Eclectic (OLI) Paradigm

Dunning (1988) completes Adam Smith"s, David Ricardo"s and Michael Porter"s research with his “Eclectic Paradigm”, also known as the “OLI” paradigm. He argues that the degree in which MNE"s will engage in foreign production will depend on the comparative ownership “O” advantages and comparative location “L” endowments of the host country and host country firms. Ownership advantages are of three types.

1- Firm specific such as: access to markets or raw materials not available to competitors; possession of exclusive intangible assets such as: patents, trademarks, management skills, technology which gives the firm an edge on the competition.
2- Ability for the firm to better coordinate interactions with the market by benefiting from endowments of the parent company. Such endowments can be: access to cheaper inputs, knowledge of markets, centralized accounting procedures, etc. This advantage is gained at zero or low marginal cost in respect to the other firms.
3- The third advantage arises from the multinationality of a firm as the more subsidiaries and the greater the differences between their economic environments, the better they are placed to take advantage of different country specific characteristics and risk profiles

The basis of the paradigm is that a firm holding “O” advantages is best to exploit them in order to take advantage of a country"s (other than the home base country) “L” advantages as long as it internalizes “I” the advantages versus licensing or selling them to another firm as it gives the holder of the advantages a type of monopoly over its rivals. Table 7 gives an extended view of the multiple ownership, location and internalization advantages Dunning (1988) is referring to.

Table 7 The Eclectic Paradigm of International Production

1. *Ownership-Specific Advantages* (of enterprises of one nationality (or affiliates of same) over those of another)
   a. Property right and/or intangible asset advantages
      Product innovations, production management, organizational and marketing systems, innovatory capacity; non-codifiable knowledge; 'bank' of human capital experience; marketing, finance, know-how, etc.
   b. Advantages of common governance
      i. Which those branch plants of established enterprises may enjoy over *de novo* firms. Those due mainly to size and established position of enterprise, e.g. economies of scope and specialization; monopoly power, better resource capacity and usage. Exclusive or favoured access to inputs, e.g. labour, natural resources, finance, information. Ability to obtain inputs on favoured terms (due e.g. to size or monopsonistic influence). Exclusive or favoured access to product markets. Access to resources of parent company at marginal cost. Economies of joint supply (not only in production, but in purchasing, marketing, finance, etc., arrangements).
      ii. Which specifically arise because of multinationality. Multinationality enhances above advantages by offering wider opportunities. More favoured access to and/or better knowledge about international markets, e.g. for information, finance, labour, etc. Ability to take advantage of geographic differences in factor endowments, markets. Ability to diversify or reduce risks, e.g. in different currency areas, and/or political scenarios.

2. *Internalization-Incentive Advantages* (i.e. to protect against or exploit market failure)
   Avoidance of search and negotiating costs.
   To avoid costs of enforcing property rights.
   Buyer uncertainty (about nature and value of inputs (e.g. technology) being sold).
   Where market does not permit price discrimination.
   Need of seller to protect quality of intermediate or final products.
   To capture economies of interdependent activities (see b. above).
   To compensate for absence of future markets.
   To avoid or exploit government intervention (e.g. quotas, tariffs, price controls, tax differences, etc.).
   To control supplies and conditions of sale of inputs (including technology).
   To control market outlets (including those which might be used by competitors).
   To be able to engage in practices, e.g. cross-subsidization, predatory pricing, leads and lags, transfer pricing, as a competitive (or anti-competitive) strategy.

3. *Location-Specific Variables* (these may favour home or host countries)
   Spacial distribution of natural and created resource endowments and markets.
   Input prices, quality and productivity, e.g. labour, energy, materials, components, semi-finished goods.
   International transport and communications costs.
   Investment incentives and disincentives (including performance requirements, etc.)
   Artificial barriers (e.g. import controls) to trade in goods.
   Infrastructure provisions (commercial, legal, educational, transport and communication).
   Psychic distance (language, cultural, business, customs, etc., differences).
   Economies of centralization of R & D production and marketing.
   Economic system and policies of government; the institutional framework for resource allocation.

Source: Dunning (1988: 27)

1.3.4 The Financial and Political Factors

Blonigen (2005), highlights the empirical literature on FDI determinants to be based on exchange rates, taxation, Institutions, trade protection and trade effects and that FDI is more likely to originate in countries abundant in capital and skilled labor which is necessary for generating firm specific assets which create the need to internalize through FDI. Other authors such as Dunning (1993) state that empirical studies that investigated the location advantages-based variables of the OLI triad found that market size, market growth, barriers to trade, wages, production, transportation and other costs, political stability, psychic distance, and host government"s trade and taxation regulations affected location decisions. When analyzing Dunning"s OLI paradigm, an MNE is to invest in the most advantageous location but only takes into account the specific MNE and the specific location. Because MNE"s compete on a global scale, one has to look at MNE"s as a group and in the context of the bandwagon effect[1]. Sethi et al (2003) add that MNE"s generally evaluate FDI"s on a regional instead of a single country basis and that geographically contiguous countries are likely to have similar cultures, political and economic systems and development levels which are often part of an economic trade group such as the EU, ASEAN, MERCOSUR, etc. According to Dunning (1993), FDI"s into these trade group"s enable MNE"s to exploit the advantages of economic integration and to capitalize on an international division of labor. The empirical literature enumerates a plethora of FDI determinants. However, exchange rates, taxes and institutions appear to be the main financial and political incentives that drive FDI"s.

1- Exchange rates can affect inward or outward FDI, all depending on the firm"s situation. As an example, an appreciation of a firm"s home country"s currency would lower the costs of assets abroad giving it a higher purchasing power and enticing firms to increase investing abroad since they have access to low cost funds whereas their counterpart firms in the foreign country would withhold such investments. Furthermore, an exchange rate appreciation can lead to a transfer of foreign assets such as technology or managerial skills at a lesser cost without involving a currency transaction (Blonigen 1997).

[1] The bandwagon effect is a psychological phenomenon whereby people do something primarily because other people are doing it, regardless of their own beliefs, which they may ignore or override.

2- Studying the effect of taxes in relation to FDI is a tricky affair. General assumption is that a higher taxation rate in a given location would deter investments from foreign companies. This assumption might be true if all things are equal elsewhere; however, taxation is a sophisticated and complicated matter which can be misleading. Most of the empirical studies point out that the effect of taxes on FDI can vary substantially by type of taxes, measurement of FDI activity, and tax treatment in the host and parent countries (Blonigen 2005). As it is often unavoidable to have to pay host and parent country taxes on earnings incurred abroad (double taxation), parent firms" taxation rates vary depending of the home country taxes, the foreign subsidiary"s taxation rates and on strategies of earnings and asset repatriation. An example of low taxation rates along with strategies of earnings and asset repatriation can be found in the double Irish Dutch sandwich[2] scheme where, large MNE"s have been able to drop their worldwide taxation rates down to single digits (Drucker 2010).

3- Institutions play an important role in setting the rules for firms, labor rights, land use, countries internal and external markets such as quotas, import tariffs and licenses, taxes, anti-trust policies, etc. It serves as a protection to its country"s inhabitants, firms and markets. The quality of the institutions in a country/region will most likely be an important determinant for FDI activity and in particular in less developed countries. According to Blonigen (2005), the main hypotheses in regards to poor institutions can lead to poor legal protection of assets which increases the chance of expropriation of a firm"s assets; it increases the costs of doing business due to various factors such as corruption and often leads to poor infrastructures which lead to lower profitability and lower FDI investments. Even though this is hypothetically true, firms also adapt and take advantage to markets with poor institutions. Depending on markets served by a firm, some firms will locate where it can maximise profits by utilizing the cheapest labor, take advantage of the lowest health, safety and environmental regulations as seen by the race to the bottom hypothesis (Drezner, 2006). On the other hand, firms such as in R&D, are taking advantage of their home country"s strong institutions by conducting R&D with high intellectual property (IP) in their home country and performing R&D of low IP in countries that have weak institutions in order to take advantage of the low wages and high education while minimizing the risks associated to the theft of IP of such countries (Zhao, 2005). Sethi et al (2003)

[2] A tax avoidance technique employed by certain large corporations, involving the use of a combination of Irish and Dutch subsidiary companies to shift profits to low or no tax jurisdictions. The double Irish with a Dutch sandwich technique involves sending profits first through one Irish company, then to a Dutch company and finally to a second Irish company headquartered in a tax haven.

add that the role of institutions cannot be over-emphasized because a stable political and economic environment, the rule of law, a sound infrastructure, an educated and technically skilled work force, low wages, an open economy and a stable currency is conducive to FDI"s. In the lens of transaction cost economics, Williamson (1985), MNE"s ask themselves the question if they should make or buy a specific good due to the coordination costs and transactions risks that stem from bounded rationality, opportunism, asset specificity and uncertainty. Issues that are raised by MNE"s are such as project specific incentives, tax breaks, restrictions on investment limits, majority control and profit repatriation, stipulations about local content, technology transfer and export requirements (Sethi et al 2003). In all, institutions have mitigated effects in regards to firms and this is mainly viewed as a risk reward base when looking into countries with weak institutions. They also play a huge role in shaping the landscape for MNE"s FDI decision process as well as their home base market outcome.

Today"s MNE"s operate in a dynamic environment which is spatially challenging. There are no perfect recipes which dictate where and how it will locate a subsidiary or a new entity because MNE"s now compete internationally and have to cross borders to take advantage of the different location advantages which will give them access to new markets and become more competitive. Furthermore, firms are all unique in their own way and because of their specificities and macro and micro contexts; they cannot be compared as groups to explain why some locations are preferred to others. Most firms have differing reasoning of why they have crossed borders, where they decided to locate and how they organised themselves internationally. This is the main underlying reason why empirical studies have not been able to arrive at a general consensus which would explain specific location based determinants. However, most of the theories help understand the big picture on the “why”, “how” and “where” MNE"s locate.

1.4 Logistics Clusters

Over the past century, corporations have paved a new landscape. Supply chains have become nimble over time and much longer and complex than ever before due to globalization, Information technology and corporate structures. The logistics function which assures that the right product is in the right place, at the correct quantity, in the right time span and at the lowest total cost has become overly important. Just as important is the phenomenon of logistics clusters which reveals insights of corporate competitive strategies and the role of location as a competitive advantage. Clusters date back to a couple of centuries with geographical concentrations of industries. They are now found all over the world such as in Silicon Valley (information technology), New York and London (finance) and in northern Italy (textiles and fashion) to name a few. The notion of clusters is not new and can be traced back to Alfred Marshall (1920) who focused a lot of attention on recognizing that firm clustering or agglomerations which had related interests created external economies to cluster partners, also known as agglomeration economies. This was namely due to an access to a pooled labor market, shared specialized inputs and knowledge spillover from competing firms. Alfred Weber was another author who came to the same conclusions of Alfred Marshall as discussed in the historical review. Weber presented two types of economies produced when firms were part of an agglomeration. The first being internal to the firm such as lowering production costs when a firm expands its plant. The second being external to the firm are referred to as spillover or neighbourhood effects such as improvements made to a product without increase of cost by a supplier and/or improvements in the labor force due to education programs. These types of external economies are known as nonmarket interdependence. Market dependent economies arise when transport costs are reduced and/or when economies of scale are realized, lowering the price to the market (Nicholson 1976). The old adage of location and trade theory would lead one to think that the general view of having access to markets, labor, raw materials and transportation were imperative for a firm"s success and an important contributor to the location of firms. However, the internationalization of firms and markets has changed this conventional view as the traditional factors are now less dominant due to many factors discussed in the economics section. Furthermore, containerization, near shoring, outsourcing of transport and logistics services, global sourcing and shorter product life cycles have had a great impact on firms and supply chains which has led to an acceleration, concentration and specialization of firms. Thus, firm clustering is a phenomenon which has been given little attention in the past decades and is a major contributor to firms and their surrounding industries successes. More recently, Michael Porter (1998) expanded the views from Weber and Marshall by focussing on clusters ability to gain a competitive advantage and foster innovation by suggesting that clusters

affect competition by increasing the productivity of the collocated firms, increasing the pace of innovation and by stimulating the formation new business.

1.4.1 What exactly are clusters comprised of?

Porter (2000: 15, 16) defines clusters as: "*geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate. Clusters represent a new way of thinking about national, state, and local economies, and they necessitate new roles for companies, for various levels of government, and for other institutions in enhancing competitiveness. Clusters suggest that a good deal of competitive advantage lies outside companies and even outside their industries, residing instead in the locations at which their business units are based. Cluster thinking suggests that companies have a tangible and important stake in the business environments where they are located in ways that go far beyond taxes, electricity costs, and wage rates. Government's more decisive and inevitable influences are at the microeconomic level. Among them, removing obstacles to the growth and upgrading of the existing and emerging clusters takes on a priority. Clusters are a driving force in increasing exports and are magnets for attracting foreign investment."* Porter"s definition is a generalized concept of clusters.

This brings us to the concept of logistics clusters which are more concisely known as firms with intensive logistics operations and are found operating in clusters inside and around maritime ports, inland ports, multimodal centers, distribution centers, etc., and offering a vast array of services and products. Such companies can be categorized as logistics service providers, such as transportation carriers, warehouse operators, freight forwarders, third party logistics providers (3PL"s), customs brokers, specialized consultants and IT providers; companies with logistics intensive operations, where value added operations may be small relative to the logistics related activities, such as distributors, light manufacturing, and kitting companies; lastly there are industrial firms logistics activities, such as distribution operations of retailers and after-market parts suppliers (Sheffi, 2013).

1.4.2 What makes clusters so special?

According to Porter (2000), clusters capture important linkages, complementarities, and spillovers in terms of technology, skills, information, marketing, and customer needs across firms and industries. The connections across firms and industries are fundamental to competition, productivity and to the direction of new business formation and innovation. Furthermore, cluster firms are not necessarily competing firms but rather serve different industry segments and share common needs, opportunities, constraints, and obstacles to productivity. According to Sheffi (2013), the success of clusters is linked to the vertical and horizontal inter-firm relationships between cluster members.

1- Vertical relationships on the supply side are links between trading partners such as procurement of parts and services from suppliers prior to adding value to the purchased goods or services. On the sales side, the links are between the distributors, customers, and other service providers. The key is the management of the partner relationships as firms are moving towards outsourcing many stages of production, moving away from vertical integration. Such examples are Toyota City, Boeing in Everett, Washington or BMW in Greer, South Carolina where it employs 5000 workers but supports over 23000 jobs in the state as suppliers decided to collocate around Greer.

2- Horizontal relationships are between firms at the same stage of production, such as automobile manufacturing plants in Detroit, Michigan, or film studios in Hollywood, California. Such firms both compete and cooperate between each other in ways that benefit them. They also collaborate between corporate functions such as HR, legal, procurement, finance and supply chain management to name a few.

As the cluster grows due to firms of a certain type moving in, it attracts more suppliers and customers who also move in. This makes its governmental influence grow and leads to infrastructure investments as well as advantageous regulations which in turn attract even more firms. Sheffi (2013) refers to this phenomenon as a positive feedback or reciprocal reinforcement forces. Just like people tend to cluster in urban areas, all supporting services and population necessities tend to cluster in the urban areas as well such as hospitals, stores, financial and legal services, education services, etc. Just as in urban centers, logistics clusters benefit from the same advantages, such as economies of scope, scale, density and frequency of transportation services. Economies of scope arise due to the presence of many shippers which speeds-up the idle time and offers a better utilization of equipment enabling cargo and equipment to be quickly and effectively shipped in and out the cluster. Economies of scale are a result of

the economies of scope which provide lower transport costs due to the concentration firms and the larger volumes of freight transiting in and out of the cluster. Economies of density and frequency arise because of the larger number of firms in the cluster which leads to a higher efficiency, frequency and fluidity of transportation services as well as a higher level of service. These economies are win-win factor conditions for firms in the cluster but need to be nurtured in order to gain the benefits. Sheffi (2013) advances that clusters form due to the following five factors:

1- Trust: clusters are formed by people with similar backgrounds, language, culture, religion and customs. Because of this it is easier to develop trust between organizations and people which reduces the transaction cost between firms and their trading partners and/or horizontal collaborators/competitors. In most cases, this trust is forged outside the work environment, citing Hollywood"s, Wall Street and Silicon Valley"s deal making ability where their reputation and familiarity gives them a competitive advantage over outsiders.

2- Tacit knowledge exchange: Knowledge is one that cannot be easily codified in an e-mail sent to a supplier where it requires discussions over specifications or exchanging benchmarking information on a competitor or supporting a customer. When this takes place in a cluster the exchange is made easier, faster, less expensive and more effectively such as face to face meetings. This also leads to knowledge spillovers whereas an informal knowledge is being exchanged between programmers, traders, technicians, etc.

3- Collaboration: There is a rise of joint activities from firms concentrated in the same industry who have similar needs and concerns such as lobbying for the provision of infrastructure, regulatory relief, incentives, and other government concerns; development of and participation in organizations dedicated to the cluster development, such as chambers of commerce; developing cluster-focused procurement strategies, leading to lower costs and higher quality for all members; engaging in cluster-specific marketing and branding activities; etc.

4- Research and education: The strength of engineering and computer science in Stanford University and Bio-technology and engineering at MIT means that companies located close to them have access to state of the art research and pool of educated employees/students, enabling university students to work on companies problems with real data inside the university labs.

5- Supply base: Clusters attract suppliers who see advantages in locating next to their customers. It gives them a chance to directly interact with customers and obtain knowledge of where their business is heading and to forge strong, trusting

and collaborative relationships. Vice versa, for the customer, a strong supplier base enables them to get competitive pricing as well as innovative suppliers which are crucial for competitiveness.

The prevalence of logistics clusters has not yet been demonstrated as the academic literature only includes a few articles about logistics clusters (Riviera et al, 2013). This is mainly due to a recent interest in regards to logistics clusters and that logistics clusters have only been intensively taking shape over the past 1-2 decades with little hype from their members. This timeline also coincides with the fast pace of internationalization of firms and the globalization of manufacturing and supply chains. The benefits of clusters are numerous and are inherently tied into location factors, trade theory, governmental policies, competitive and comparative advantages, corporate strategies and FDI, to name a few.

2 Problem description

This thesis will cover an actual location analysis problem. We will be studying a company called Ray-Mont Logistics who wishes to locate a grain transloading terminal. The company is contemplating an international expansion to the United States but is still undecided on the exact location of the terminal.

2.1. General description of Ray-Mont Logistics

Ray-Mont Logistics is a privately held 3PL grain[3] transloading company that operates two terminals in Canada (Vancouver and Montreal) as well as a freight forwarding department in Montreal and another one in Spokane, Washington, which enables Ray-Mont to offer turnkey services to its clients. The company was founded in 1992 by François Raymond, a truck driver who saw an opportunity in the agriculture business of containerization. It is now run by his son Charles Raymond who has been expanding its roots for the past 10 years. Its headquarter located in Montreal handles all the accounting, IT, finance, customer service and Canadian based freight forwarding. The company has about 200 employees. Ray-Mont"s clients are composed of the largest grain producers in Canada and in the United States as well as grain trading companies which grow, clean, ship, and/or trade lentils, peas, beans, soy, wheat, canary, millet, mustard, flax, etc., just to name a few grain varieties. There has been a lot of consolidation over the past years in regards to grain companies but there still remains a considerable amount of vertical synergies between farmers, vertically integrated companies, grain traders, grain cleaners, etc.

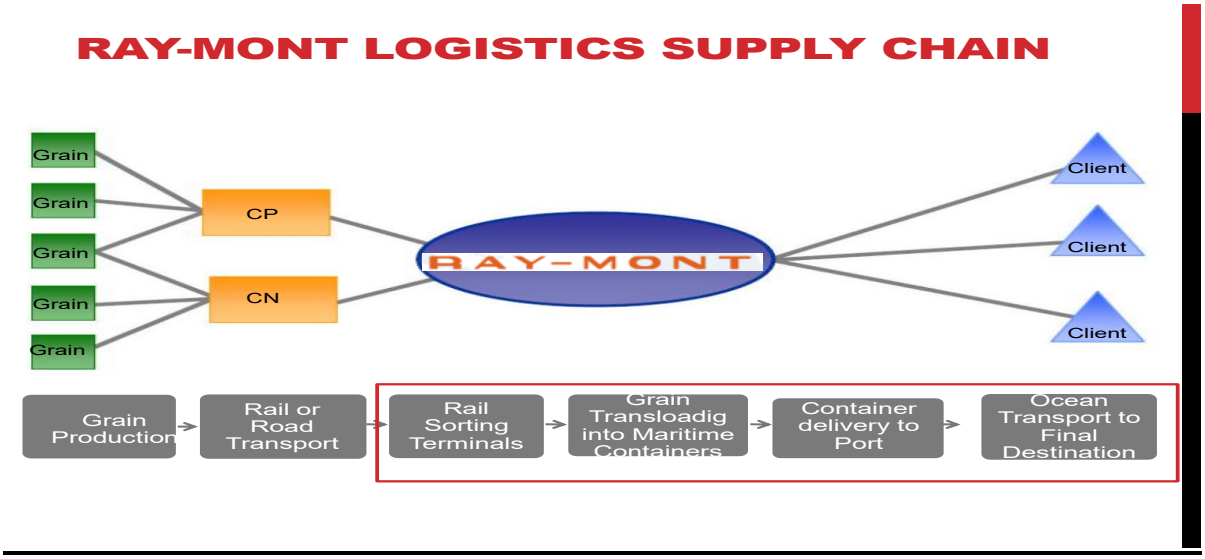
[3] In order to simplify the various definitions and groups of grains, we will use the generic term “grain” to characterize all grain types, including pulses such as lentils, beans, peas, etc.

2.2. Supply Chains: Ray-Mont Logistics, Railways and Maritime Container Lines

2.2.1 Ray-Mont logistics

The grain is grown mainly in Saskatchewan, Manitoba, Alberta and in the Midwestern United States and shipped by railcar or Intermodal[4] to Ray-Mont"s terminals on each coast. Figure 3 depicts the company"s supply chain and its supporting activities.

Figure 3 Ray-Mont Logistics supply chain



Source: Cantera-Larkin, 2015

In essence, Ray-Mont"s role is to manage the supply chain from the moment cargo is released from the clients" ship point till the final destination when the clients" clients take possession of the cargo. The cargo mainly moves inland by rail (railcars or intermodals) but it can seldom move by road when equipment is scarce or for contractual reasons[5]. Road shipping isn"t used very often because of its much higher costs per tonne versus rail. Ray-Mont manages its sophisticated supply chain with the use of a powerful in house Enterprise Resource Planning (ERP) system which is specifically tailored to its industry.

[4] The term intermodal in this thesis refers to a 48-53ft inland container that cannot be used for export by sea

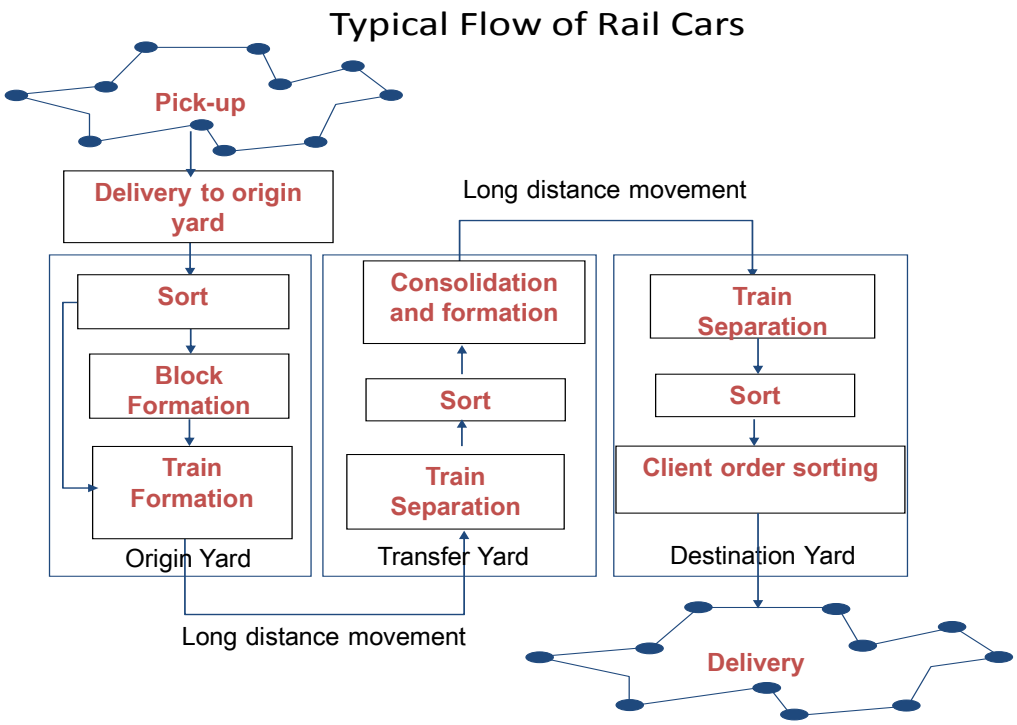
[5] Ray-Mont's clients also perform reverse logistics by importing grain to local markets but it's a small percentage of clients and Ray-Mont's overall business.

2.2.2 Railways

Railways move railcars and intermodals to and from terminals across the country and then perform the final leg from the final terminal to the client. Railcars generally take on average three weeks from the clients" ship point to the Montreal Terminal. However, Intermodals which also travel a majority of the way by rail only take on average 1 week. This is mainly due to minimised sorting and fewer stops at hubs on the way as well as not having to do a final sorting by matching individual railcars and delivering them to the end client. Road trucks make up for the higher costs with a transit time of about two days.

Figure 4 depicts how the rail supply chain flows.

Figure 4 Typical flow of rail cars



Source: Roy, 2011

In Canada, there are two class one railways, a duopoly composed of Canadian Pacific (CP) and Canadian National (CN). They run their own rail network from coast to coast and serve markets exclusively along their separate lanes (see figure 5). Some of Ray-Mont‟s clients are not directly served by CN or CP due to their geographical location and use a private railway to perform the last mile deliveries of railcars. Furthermore, Ray-Mont‟s US clients‟ railcars are moved by a US railway to an interchange rail terminal in the US (generally Chicago for Montreal destination) and then turned over to CN or CP to perform the second leg to Canada and Ray-Mont‟s Canadian terminals. In regards to intermodals, the location of a client‟s plant (just like with railcars) will determine if CN or CP will be the chosen carrier. Furthermore, clients‟ plants are generally configured to load Intermodal or rail traffic or both. This is the reason why a client will chose one mode over another. Lastly, the use of only intermodal transport from a client‟s plant generally means that plant has no access to a railway.

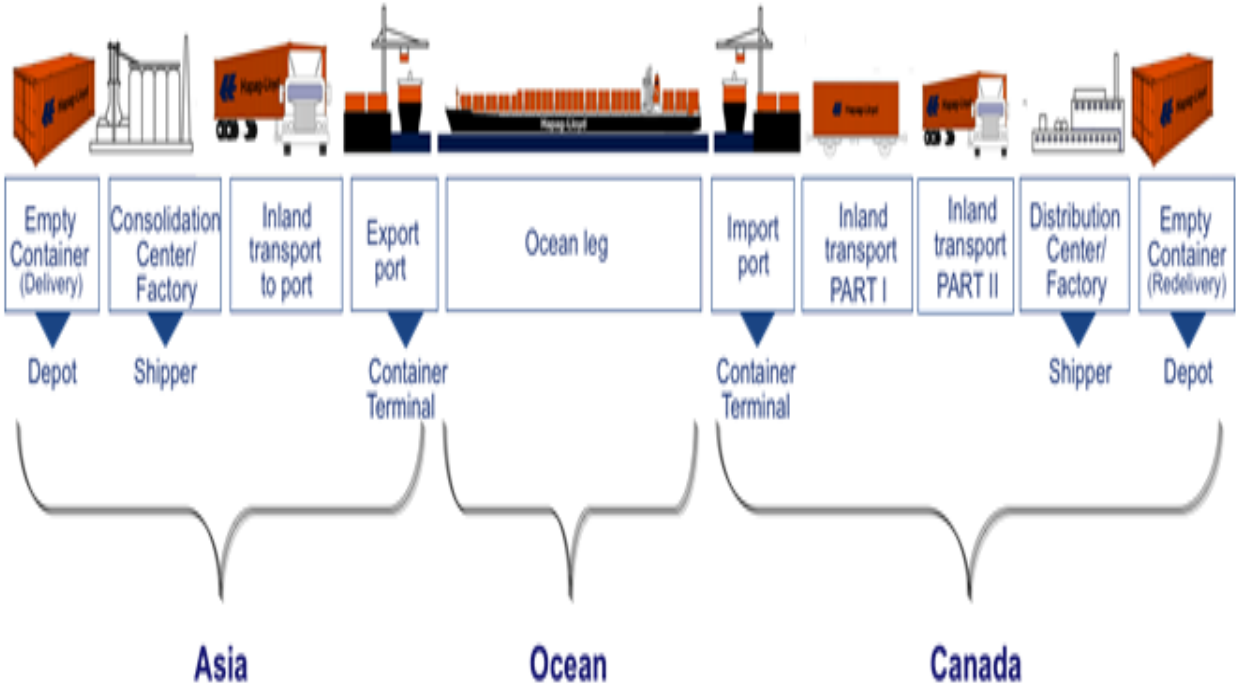
Figure 5 CN and CP Canadian rail network

Source: Canadian Railway Atlas, 2003

2.2.3 Maritime Container Lines

Once cargo via railcar and intermodal arrives at Ray-Mont‟s terminals, the cargo is then transloaded into maritime containers measuring 20 or 40 feet. Empty export containers are generally picked-up at a port location or at a depot. Ray-Mont‟s terminals operate as container depots for most maritime lines and generally take empty containers from their inventory. Once the export container is loaded, it is delivered to a port location for immediate loading onto a vessel or to a railway in order to be railed to an export port. Figure 6 further exemplifies the supply chain of a container.

Figure 6 Maritime container supply chain



Source: Roy, 2011

2.3 Types of railcars and intermodals used to transport grain

1- Box Car: A box car, as depicted by Figure 7, is a rectangular shaped railcar that has doors on both sides and located at the middle of each side. Box cars destined to Ray-Mont generally only contain bagged grain product of various sizes and a total transported net grain weight between 150,000lbs and 200,000lbs.

Figure 7 Box Car

Source: Cantera-Larkin, 2015

2- Hopper car: A hopper car, as depicted by Figure 8 is composed of hoppers commonly known as hatches or compartments which contain grain in bulk. Each hatch can hold a different type of grain if needed. They are generally composed of 3-4 hatches and transport between 180,000-220,000 lbs of grain. This type of railcar is filled-up by the top and emptied at the bottom. Figure 9 is a close-up of the bottom hatch being unloaded. The grain is falling into a pit in the ground that is connected to a conveyor belt.

Figure 8 Hopper Car

Source: Cantera-Larkin, 2015

Figure 9 Bottom hatch of a hopper car

Source: Cantera-Larkin, 2015

3- Intermodal: Intermodal transport as previously defined is a 48-53 foot inland container which is trucked to a rail yard, then railed to the destination terminal and lastly trucked to the final client. The container is separate from the frame that connects to the wheels. In essence it is removed from the wheels during rail transport. It can contain bulk or bagged product. Figure 10 is an example of a bulk loaded intermodal being lifted at a 45 degree angle in order to empty the cargo. Intermodals generally contain around 60000lbs.

Figure 10 Bulk intermodal unloading

Source: Cantera-Larkin, 2015

2.4 Ray-Mont Logistics Terminal Services

1- Bulk to Bulk: For this service grain arrives in bulk via an intermodal, hopper car or storage container[6]. Cargo is transloaded into an export container without transforming its state. i.e. product stays in bulk. This all works by opening the bottom hatches on the hopper car and/or tilting the intermodal or storage container. The product then is moved via a conveyor belt that feeds a bulk plant which in turn elevates grain with a bucket elevator that ultimately releases the grain into an export container. Figure 11 is an image of the Montreal bulk plant. Figure 12 is an image of a container in loading and figure 13 is a loaded completed container with a retaining wall.

[6] Ray-Mont has many storage containers available to clients in case there is overstock, lost sale or postponement need.

Figure 11 Montreal Bulk Plant

Source: Cantera-Larkin, 2015

Figure 12 Container loading at a 45-90 degree angle

Source: Cantera-Larkin, 2015

Figure 13 Loaded bulk container with retaining wall.

Source: Cantera-Larkin, 2015

2- Bulk to Bag: For this service grain arrives in bulk via an intermodal, hopper car or storage container. Cargo is then routed via a conveyor to a bagging facility where the product is transformed into a bagged state and then moved by a conveyor to a person who manually piles the bags into the container. Bag types are generally 100lbs, 50kg, 20kg, 25kg or 50lbs. Figure 14 is an image of the bagging line.

Figure 14 Bagging line

Source: Cantera-Larkin, 2015

3- Bag to Bag: For this service, grain arrives in bags via a box car, intermodal or road truck. The bags are transloaded with the use of a mobile conveyor. At one end of the conveyor there is a person who pulls the bags onto the conveyor and at the other end someone who piles them into the export container. Figure 15 is an image of an extended mobile conveyor into a box car.

Figure 15 Box car unloading to a container

Source: Cantera-Larkin, 2015

Some grain types such as beans leave a lot of air pockets when loaded with bags. Containers can be loaded passed the doors with the use of an exterior plate. The use of this plate is to be able to add an extra 10-15% of bags into the container. See figure 16. In order to close the doors, the container is brought to a tipping platform that tilts the container vertically and all the bags then fit snugly into the container. See figure 17. This also applies to bulk to bag service.

Figure 16 Container loaded over capacity with a plate

Source: Cantera-Larkin, 2015

Figure 17 Tipping platform

Source: Cantera-Larkin, 2015

4- Totes: Totes are commonly known as large bags, generally between 2000-4000lbs. For this service grain arrives in totes via an intermodal, box car or storage container. The cargo is transloaded with the use of a forklift. Figure 18 is the image of a partially loaded container of 2000lbs totes.

Figure 18 Tote loading

Source: Cantera-Larkin, 2015

5- Import: Import service consists of transloading an import container containing totes, bags or bulk and transferring the cargo into a hopper car, box car, intermodal, road truck or storage. It can also require the unit size to change, i.e. bags ripped into bulk and then loaded into a hopper car.

3 Methodology

3.1 Determining alternative locations

The goal of the thesis is to find the best location for a grain transloading terminal in the United States subject to a set of location factors, criteria and alternatives. In order to find contenders, a complete list of U.S. discrete locations limited to costal ports was presented to Ray-Mont Logistics upper management and board of directors. The upper management and board of directors is composed of seven members: the President and CEO, the VP Marketing, VP Operations, VP Human Resources, US branch manager, Vancouver Terminal Manager and Montreal Terminal Manager. A set of four documents was given to the upper management in order to assist in the decision process and can be found in appendices 1 to 4. Appendix 1 contains an aggregated grain export twenty foot equivalent units (TEU) U.S. port list from 2008-2012 which was taken from the Upper Great Plains Transportation Institute study of Marketing U.S. Grain and Oilseed by container. Their dataset came from a paid subscription from JOC Group Inc."s Port Import Export Reporting Services (PIERS) database. Appendix 2 contains the list of disaggregated quantity of grain TEU"s by port district given in Appendix 1 from 2003-2012 and from the same source. Appendix 3 contains the top 20 U.S. ports moving waterborne agriculture trade in metric tons and the data was taken from the Agricultural Marketing Service of The United States Department of Agriculture. It differentiates the imports and exports but aggregates bulk vessel exports and containers. Their dataset was also taken from PIERS. Lastly, Appendix 4 contains the amount of TEU handled (imports and exports) in U.S ports (>250000TEU) between 2008 and 2013. The data was taken from the American Association of Port Authorities.

Based on the upper management and board of director"s knowledge of U.S. markets and with the help of data provided in appendices 1 to 4, the group was asked to come up by informal consensus with the five best locations to base the study on. The consensus took place during a managers" meeting on November 18th 2015.

The five port districts which were chosen are: Los Angeles (port of Los Angeles and Long beach), Seattle (port of Seattle and Tacoma), Hampton Roads (also known as Norfolk), Houston and New Orleans.

We limited the site selection to coastal ports because the data was easily obtainable and didn"t need any manipulation. The inland port of Chicago would have been a great contender for the study but needed an accessible and verifiable data set as well as a lot of data manipulation as its export containers are shipped to the five port districts selected.

3.2 Determining the location factors and criteria

Once the alternative locations were chosen by the upper management and board of directors, the analytic hierarchy process (AHP) technique was used to analyse and select the best location. As explained in the literature review, this technique has many advantages which enable the decision makers to combine qualitative and quantitative data, use human judgements from various sources, compare criteria and alternatives in a pairwise comparison to just name a few. In this step, we have to select the location factors and criteria which will be evaluated. AHP only allows a maximum of seven location factors (criteria) in order to maintain the consistency index (CI) lower or equal to 10% (Saaty 2013). Furthermore, the AHP theory has to follow a homogeneity axiom whereas only comparable elements are compared to avoid judgement errors when comparing very disparate elements. Because of these limitations, six location factors were selected and subject to twenty-one criteria clustered under specific location factors. The location factors and the criteria were selected from various sources which best represent the industry and Ray-Mont Logistics. Table 8 contains the hierarchical structure of evaluation.

Table 8 Evaluation hierarchical structure for grain terminal selection

Goal	Location factors	Criteria
Best location of grain terminal	1- Port attractiveness	*1- Total TEU
		*2- Export grain TEU
		*3- Empty container availability
		4- Flexibility
		5- Long term growth of business
	2- Logistical activity	*6- Logistics cluster size
		*7- Free trade zone size
		*8- Quantity of logistics jobs
	3- Rail and seaway cost	9- Rail cost
		10- Export container cost
	4- Transportation advantage	*11- Road weight restrictions
		*12- Road congestion
		*13- Size of trucking industry
	5- Economic costs	*14- Land cost per acre
		*15- Construction cost per square foot
		*16- State tax rate
		*17- Median wages
	6- Local economy	*18- Unemployment rate
		*19- Business climate
		*20- Education level
		*21- State incentives

* Criteria which will be quantitatively evaluated

AHP Example.

The following example was taken from Saaty (2013). The goal is to buy the best car as represented by the hierarchy in figure 1. The criteria are prestige, price, MPG (miles per gallon) and comfort. The alternatives are the Acura TL, the Toyota Camry and the Honda Civic. Once the hierarchy of the problem has been determined the decision makers such as scholars, key corporate personnel, specialists, consultants, etc. are asked to rank the criteria which generate the pairwise comparison table given in table 2. Furthermore, when a same criterion is compared to itself, a value of 1 is inserted and once combining pairs of criteria are graded (Ex: price vs prestige and prestige vs price) their reciprocal value is used for their second combination.

Table 2 Pairwise comparisons of the criteria as to their importance in choosing best car.

Goal	Prestige	Price	MPG	Comfort	Priorities
Prestige	1	1/4	1/3	1/2	0.099
Price	4	1	3	3/2	0.425
MPG	3	1/3	1	1/3	0.169
Comfort	2	2/3	3	1	0.308

Source: Saaty (2013 : 1107)

The last column in Table 2 is the normalization or weight attributed to each criteria also called Eigen vector or Priority vector. In this case, the decision makers ranked in order of importance; price, comfort, mpg and lastly Prestige. The weight is obtained by the average of the division of the row by the column sum. Saaty (2013) refers to this as the distributive mode of synthesis which is the process of weighting, adding, and normalizing priorities to 1. In contrast, if one divides by the largest priority among the synthesized values, the result is referred to as an ideal mode of synthesis.

Once the pairwise comparisons have been completed, we need to compare the alternatives to the criteria as seen in table 3(a)-3(d). The data is compiled with the input of the decision makers. The same normalization process occurs and a priority ideal is set. The highest normalized value in each section is given a value of 1(priority ideal), the other alternative values (priority ideal) are a proportional comparison of their value in respect to the criteria leader.

Table 3 Pairwise comparisons of the alternatives as to their importance in choosing best car.

(a) Comparison of cars with respect to prestige

Prestige	Acura	Toyota	Honda	Priority distributive	Priority ideal
Acura TL	1	8	4	0.707	1.000
Toyota Camry	1/8	1	1/4	0.070	0.099
Honda Civic	1/4	4	1	0.223	0.315

(b) Comparison of cars with respect to price

Price	Acura	Toyota	Honda	Priority distributive	Priority ideal
Acura TL	1	1/4	1/9	0.063	0.085
Toyota Camry	4	1	1/5	0.194	0.261
Honda Civic	9	5	1	0.743	1.000

(c) Comparison of cars with respect to MPG

MPG	Acura	Toyota	Honda	Priority distributive	Priority ideal
Acura TL	1	2/3	1/3	0.182	0.333
Toyota Camry	$1\frac{1}{2}$	1	1/2	0.273	0.500
Honda Civic	3	2	1	0.545	1.000

(d) Comparison of cars with respect to comfort

Comfort	Acura	Toyota	Honda	Priority distributive	Priority ideal
Acura TL	1	4	7	0.705	1.000
Toyota Camry	1/4	1	3	0.211	0.299
Honda Civic	1/7	1/3	1	0.084	0.119

Source: Saaty (2013: 1107)

It is also possible to use actual measurements instead of judgements as seen in table 4. Thus, if we take the price of each car, we can turn the numbers into ratios. Note that in this case, the lower number the higher the priority and the inverse of the ratio has to be computed.

Table 4 Alternate way of evaluating alternatives in respect to a criteria

Price in dollars	Average prices	Normalized prices used as priorities	Invert priorities	Final priorities (normalized)	Ideal priorities
1 Acura TL	32,500	0.425	1/0.425	0.246575	0.554
2 Toyota Camry	26,000	0.340	1/0.340	0.308219	0.692
3 Honda Civic	18,000	0.235	1/0.235	0.445205	1.000
Sum	76,500	1	0.00012479	1	

Source: Saaty (2013: 1108)

Table 5 gives the synthesis of the priorities of the alternatives shown in the next-to-last columns of Table 3(a)-3(d) multiplied by the priorities of the criteria given in the last column of Table 2. The Honda Civic is the winner because its overall priorities are larger than its rivals.

Table 5 Synthesis of the priorities of the alternatives

Priorities	Prestige 0.099	Price 0.425	MPG 0.169	Comfort 0.308	Synthesis of overall priorities
Acura TL	0.707	0.063	0.182	0.705	0.342
Toyota Camry	0.070	0.194	0.273	0.211	0.204
Honda Civic	0.223	0.743	0.545	0.084	0.454

Source: Saaty (2013: 1107)

There is a second method that can be used to declare a winner. As Saaty (2013: 1107) mentions: "*Psychologists have noted that there are two ways to make comparisons and alternatives. One is to compare them by considering each pair, as we have done above, and the other is to compare each alternative with an ideal one has in mind. Because in the case of cars we only know about the three cars we are considering, we make the best of them under each criterion by the largest among them, and that one becomes the ideal*". By using the values of the last column of Table 3(a)-3(d) (priority ideal), we obtain Table 6. Note that the normalized priorities have remained the same and only the alternative priorities have changed. The end result stays the same.

Table 6 Ideal mode synthesis

Priorities	Prestige 0.099	Price 0.425	MPG 0.169	Comfort 0.308	Overall priorities	Normalized
Acura TL	1.000	0.085	0.333	1.000	0.499	0.342
Toyota Camry	0.099	0.261	0.500	0.299	0.297	0.204
Honda Civic	0.315	1.000	1.000	0.119	0.661	0.454

Source: Saaty (2013: 1108)

It is important to note that there are many theorems as well as proofs found in Saaty (2013) and Saaty (1990) that further explain and demonstrate the mathematics behind this overall approach as well as a consistency Index (CI) <10% that needs to be respected in order for the results to be consistent with the data.

3.3 Questionnaire and AHP matrixes

3.3.1 Ranking location factors

Once all the location factors and criteria have been selected, a questionnaire was developed and sent to Ray-Mont Logistics upper management and board of directors. Clients were omitted from the questionnaire due to confidentially reasons. The questionnaire was broken down into three sections. The first section asks participants to rank pairwise location factors in regards to other location factors. Each location factor is compared with the others individually on a scale of 1-9 (see Table 9) to determine the most desirable from the least desirable in order to develop the matrix which will generate the weights. A series of fifteen two tier questions (see Appendix 5) was developed to rank the location factors found in Table 8 under ranking location factors part 1. The goal of the questionnaire is to know how location factors rank among each other and to obtain a weight which will be distributed to the criteria. While comparing the location factors, the questionnaire is designed to determine which of the two pairwise location factors is preferred and by how much. These two conditions are necessary in order to properly fill the matrix in appendix 7. The results are inserted in appendix 8 and

disaggregated to show the differences with the class of respondents as well as the coefficient of variation.

Table 9 Pairwise Comparison Scale

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another.
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another.
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance is demonstrated in practice.
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
1.1–1.9	When activities are very close a decimal is added to 1 to show their difference as appropriate.	A better alternative way to assigning the small decimals is to compare two close activities with other widely contrasting ones, favoring the larger one a little over the smaller one when using the 1–9 values.
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	This is logical assumption.
Measurements from ratio scales		When it is desired to use such numbers in physical applications; alternatively, often one estimates the ratios of such magnitudes by using judgment.

3.3.2 Ranking Criteria

The second part of the questionnaire asks participants to repeat the first part of the questionnaire but this time they will be ranking the criteria instead of location factors in a pairwise fashion (see Table 8). Criteria evaluated will be clustered by location factors. In other words, criteria from port attractiveness won"t be compared to those from another group such as economic costs as they are disparate elements. This section will group the criteria evaluated by location factors and their results will be used to fill in the matrixes in Appendix 9. Appendix 10 displays the disaggregated results to show the differences with the class of respondents as well as the coefficient of variation in regards to the criteria. A series of twenty nine, two tier questions (see Appendix 5) was developed to rank the criteria found in Table 8 under ranking criteria part 2. As per section 3.3.1, the goal is to obtain a set of weights for each criteria based on the weight obtained in the location factor"s group.

3.3.3 Ranking Alternatives

This last section uses qualitative and quantitative data in order to rank and compare the five alternatives (coastal port locations) which were chosen by the upper management and board of directors at Ray-Mont Logistics. In Table 8, the criteria marked with an asterisk "*" are of quantitative nature and will be scored with the use of databases from various sources such as: The Upper Great Plains Transportation Institute, Agricultural Marketing Service of The United States Department of Agriculture, the American Association of Port Authorities, the United States Census Bureau, United States Department of Labor, etc. Flexibility, long term growth of business, rail cost and export container cost are the only criteria which will be subject to a pairwise comparison in regards to the alternatives. Rail cost and export container cost are being considered as qualitative because a quantified approach would be quite subjective. Not all costal ports offer the same final destinations for export containers and we are approaching the question broadly. IE: that an alternative coastal port has an overall better or worse cost structure; same would apply to the rail cost. The third part of the questionnaire will pairwise compare the five alternative locations to flexibility, long term growth of business, rail cost and export container cost and can be found in appendix 5 (ranking alternatives part 3). The results will be transposed into the matrixes in Appendix 11. In regards to the quantitative data, the alternatives will be individually scored by criteria. The different values (un-normalized) will be entered in the table found in Appendix 12 (criteria quantitative values of alternatives) which will then be individually normalized in the tables found in Appendix 13 along with a transposition of the data from Appendix 11.

In essence, the ranking of the location factors will give a weighted total score for all location factors equal to one, which will then be distributed among the criteria and finally the alternatives in order to find the best location. Lastly, a location factor and criteria definition was developed and distributed with the questionnaire (see Appendix 6) in order to help the respondent while answering questions.

4 Discussion of results for the location factors, criterions and alternatives

4.1 Qualitative results

The questionnaire which is the basis of the qualitative results was sent out to five upper management and board of director members and the individual questionnaire results can be found in Appendixes 14-18. As discussed earlier, it was decided by internal consensus due to strategic reasons to not send out the questionnaire to clients. The questionnaire data was entered into an AHP program developed by Klaus D. Goepel at Business Performance Management Singapore in order to compile the results. A sample calculation will be provided in section 4.3. The summarized results of the questionnaires can be found in Appendixes 20-22. The sub criterions for each section of location factors, criterions and alternatives will be discussed jointly in order to facilitate the evaluation of the results. Furthermore, as described in methodology section, four criterions were evaluated in function of the five cities and port administrations as they were judged to be of qualitative nature. The criterions are flexibility, long term growth of business, rail cost and export container cost. Lastly, the results contain the average, the standard deviation (SD) and the coefficient of deviation (CV). The coefficient of variation indicates the consensus among the group of evaluators; thus smaller coefficients indicate a higher consensus. This, however, can be a bit skewed as a reasonably low standard deviation with a small average can show a high coefficient.

4.1.1 Location factors

The results in this section (see Table 10) will affect all other subsections as they will set the percentage attributable to the criteria section which will then be redistributed to the criterions and then, to the five locations. Transportation advantage was ranked the first priority followed by rail and seaway cost, logistical activity, economic costs, port attractiveness and lastly local economy. It is a bit of a surprise to see that rail and seaway cost wasn"t ranked first as customers are very price sensitive and will generally look at total cost first. The results are however very close as transportation advantage has an average of 31.1% versus 26.2% for rail and seaway cost. Furthermore, we can see that the SD and CV are higher when comparing rail and seaway cost and transportation advantage meaning that the opinions vary among respondents which can be explained by a limited knowledge by some respondents.

Table 10 Location factor results

Location Factors	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Port attractiveness	17.40%	21.70%	3.20%	6.50%	5.40%	10.84%	5	7.3%	68%
Logistical Activity	24.60%	5.00%	15.10%	24.70%	12.30%	16.34%	3	7.5%	46%
Rail and seaway cost	45.80%	14.60%	19.30%	4.40%	47.20%	26.26%	2	17.2%	66%
Transportation advantage	6.90%	26.20%	50.90%	45.60%	26.30%	31.18%	1	15.7%	50%
Economic costs	3.10%	27.80%	9.20%	16.00%	5.50%	12.32%	4	8.9%	72%
Local Economy	2.20%	4.80%	2.40%	2.80%	3.20%	3.08%	6	0.9%	30%

4.1.2 Criteria

4.1.2.1 Port attractiveness

In regards to port attractiveness, export grain TEU was ranked as the first priority, followed by empty container availability, long term growth of business, flexibility and lastly total TEU. It would be pretty logical to assume that one should select the port that exports the most grain containers and that the other criteria should be to have sufficient empty available containers. As seen in the results (see Table 11), the respondents seem to have an overall higher consensus for the first two priorities. The standard deviation and coefficient of variation would have been much lower if respondent #2 hadn"t attributed such a low importance to export grain TEU as the other four respondents all gave a much similar relative importance to this criteria. Having removed respondent #2, would have increased the overall score of export grain TEU.

Table 11 Port attractiveness criteria results

Port attractiveness criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Total TEU	6.10%	2.70%	3.70%	3.60%	5.40%	4.30%	5	1.3%	29%
Export Grain TEU	52.00%	5.10%	44.20%	49.40%	42.10%	38.56%	1	17.1%	44%
Empty container availability	20.80%	23.80%	24.60%	17.00%	39.30%	25.10%	2	7.6%	30%
Flexibility	3.40%	16.90%	12.70%	6.20%	4.30%	8.70%	4	5.2%	60%
Long term growth of business	17.60%	51.60%	14.80%	23.80%	8.90%	23.34%	3	14.9%	64%

4.1.2.2 Logistical activity criteria

In regards to logistical activity results (see Table 12), logistics cluster size was ranked as the first priority, followed by free trade zone and lastly quantity of logistics jobs. Logistics cluster size won 55.7% of the votes and demonstrates a higher level of consensus among the respondents. This also was to be expected as corporations are more efficient and produce more synergies when they are part of a large and diverse cluster of interconnected companies.

Table 12 Logistical activity criteria results

Logistical activity criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Logistics cluster size	70.90%	58.20%	33.33%	70.70%	45.80%	55.79%	1	14.6%	26%
Free trade zone size	17.90%	30.90%	33.33%	8.00%	41.60%	26.35%	2	11.9%	45%
Quantity of logistics jobs	11.30%	10.90%	33.33%	22.30%	12.60%	18.09%	3	8.7%	48%

4.1.2.3 Rail and seaway cost criteria

In regards to rail and seaway cost results (see Table 13), rail cost was ranked as the first priority, followed by export container cost. The average score of both categories are pretty close and we can see that the standard deviation and coefficient of variation is also pretty high. This is to be expected as grain clients are just as sensible to inland and export costs. It however can be inferred that rail costs are probably much less flexible due to a lack of competition amongst the railways versus the opposite in regards to the maritime companies which compete against the same markets.

Table 13 Rail and seaway cost criteria results

Rail and seaway cost criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Rail cost	75.00%	50.00%	87.50%	16.70%	50.00%	55.84%	1	24.4%	44%
Export container cost	25.00%	50.00%	12.50%	83.30%	50.00%	44.16%	2	24.4%	55%

4.1.2.4 Transportation advantage criteria

In regards to transportation advantage results (see Table 14), road weight restrictions was preferred by 72.4% of the respondents, followed by road congestion and lastly size of the trucking industry. Furthermore, the consensus on road weight restrictions criteria is very high. This is most probably attributable to the fact the more payload allowed in a container, the lowest total cost a client will have, giving it priority over the two other criteria"s.

Table 14 Transportation advantage criteria results

Transportation advantage criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Road weight restrictions	76.90%	63.70%	80.00%	69.60%	71.70%	72.38%	1	5.7%	8%
Road congestion	14.70%	25.80%	10.00%	22.90%	8.80%	16.44%	2	6.8%	41%
Size of trucking industry	8.40%	10.50%	10.00%	7.50%	19.50%	11.18%	3	4.3%	38%

4.1.2.5 Economic costs criteria

In regards to economics costs results (see Table 15), land cost per acre was preferred by 41.8% of respondents, followed by construction cost per square foot, state tax rate and lastly median wages. The winning criteria isn"t surprising as the biggest cost for a terminal is the land it will need. Generally, the ideal location for a terminal is close to empty container terminals and to the return location of a loaded container at a port. It can be hypothesized that locations in vicinity of a port are very expensive on an acre basis thus, a city that offers a relatively low cost of land will be preferred in this category. Furthermore, construction costs across a country don"t vary as much as land costs.

Table 15 Economic costs criteria results

Economic costs criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Land cost per acre	31.00%	31.20%	26.30%	65.30%	55.00%	41.76%	1	15.5%	37%
Construction cost per square foot	54.10%	31.20%	16.30%	10.30%	13.50%	25.08%	2	16.2%	65%
State tax rate	6.50%	31.20%	10.20%	20.20%	23.20%	18.26%	3	8.9%	49%
Median wages	8.40%	6.20%	47.10%	4.30%	8.30%	14.86%	4	16.2%	109%

4.1.2.6 Local economy criteria

In regards to the local economy results (see Table 16), business climate was preferred by 33.6% of respondents, followed by state incentives, education level, and lastly unemployment rate. Business climate and state incentives only have a 0.5% difference in their scores but the respondents had a much higher consensus in regards to state incentives. The score isn"t surprising as state incentives and business climate both go hand in hand; this even more when compared to the unemployment rate and the education level which are much less important in the line of business Ray-Mont operates in.

Table 16 Local economy criteria results

Local economy criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Unemployment rate	16.80%	13.20%	4.90%	10.20%	18.30%	12.68%	4	4.8%	38%
Business climate	23.60%	42.00%	11.00%	63.20%	28.30%	33.62%	1	17.8%	53%
Education level	13.50%	6.00%	61.70%	5.20%	16.30%	20.54%	3	21.0%	102%
State incentives	46.10%	38.80%	22.40%	21.40%	37.10%	33.16%	2	9.7%	29%

4.1.3 Alternatives

4.1.3.1 Flexibility of alternative locations

In regards to the flexibility of the port administrations results (see Table 17), Los Angeles was preferred by 34.8% of the respondents, followed by Seattle, Houston, Norfolk and lastly New Orleans. As seen by the results, Los Angeles was preferred by only about 5% over Seattle. This is most probably attributable to the sheer size of the Port of Los Angeles and Long Beach which handle a wide variety of cargo over their competitors and consequently the hub for most international markets.

Table 17 Flexibility alternative results

Flexibility	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	38.10%	7.30%	50.70%	27.60%	50.50%	34.84%	1	16.2%	47%
Seattle	20.10%	36.70%	26.30%	52.80%	12.10%	29.60%	2	14.1%	48%
Norfolk	8.30%	23.30%	6.90%	3.10%	22.80%	12.88%	4	8.5%	66%
Houston	20.50%	27.90%	11.30%	5.40%	8.50%	14.72%	3	8.3%	56%
New Orleans	13.00%	4.70%	4.80%	11.20%	6.10%	7.96%	5	3.5%	44%

4.1.3.2 Long term growth of business of alternative locations

In regards to the long term growth of business of port administrations results (see Table 18), Seattle was preferred by 33.6% of respondents, followed by Los Angeles, Houston, Norfolk and lastly New Orleans. This result is in line with the fact that most grain customers are much closer geographically to Seattle and served by rail carriers which offer a shorter routing to Seattle which in turn lowers their total cost. Spatially speaking, it would make more sense to locate in relative proximity to your clients.

Table 18 Long term growth of business alternative results

Long term growth of business	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	27.90%	4.50%	48.50%	6.20%	33.30%	24.08%	2	16.7%	69%
Seattle	39.70%	36.90%	7.00%	54.20%	30.10%	33.58%	1	15.4%	46%
Norfolk	10.60%	17.80%	29.00%	3.50%	14.50%	15.08%	4	8.4%	56%
Houston	14.30%	33.60%	11.10%	13.30%	15.70%	17.60%	3	8.1%	46%
New Orleans	7.40%	7.10%	4.30%	22.90%	6.40%	9.62%	5	6.7%	70%

4.1.3.3 Rail cost to alternative locations

In regards to the rail cost to port administrations results (see Table 19), Seattle was preferred by 54% of respondents, followed by Houston, Los Angeles, Norfolk and New Orleans. As seen with the results the consensus is very high in regards to Seattle. This is in line with the comments in section 4.1.3.2 in regards to the spatial proximity. However, Houston which was ranked second shares a high consensus amongst respondents but is quite opposite to the proximity Seattle has with the clients. This could be due to a dedicated line or aggressive rail pricing from the rail carriers to move cargo to Houston versus the other port administrations.

Table 19 Rail cost alternative results

Rail cost	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	10.30%	2.80%	6.50%	11.70%	13.10%	8.88%	3	3.8%	42%
Seattle	47.40%	55.90%	53.30%	60.60%	52.90%	54.02%	1	4.3%	8%
Norfolk	10.80%	15.70%	6.80%	3.50%	3.90%	8.14%	4	4.6%	56%
Houston	21.40%	20.50%	22.30%	19.50%	22.90%	21.32%	2	1.2%	6%
New Orleans	10.10%	5.10%	11.20%	4.80%	7.30%	7.70%	5	2.6%	34%

4.1.3.4 Export container cost to alternative locations

In regards to the export container cost to alternative locations results (see Table 20), Seattle was preferred by 47.3% of respondents, followed by Los Angeles, Houston, Norfolk and lastly New Orleans. As with the past category, the consensus over Seattle seems reasonably high amongst the respondents whereas the results are a bit mitigated in regards to Los Angeles.

Table 20 Export container cost alternative results

Export container cost	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	14.30%	5.50%	60.30%	29.30%	26.60%	27.20%	2	18.6%	69%
Seattle	52.40%	54.90%	22.60%	55.40%	51.30%	47.32%	1	12.5%	26%
Norfolk	6.50%	16.30%	9.80%	3.10%	9.20%	8.98%	4	4.4%	49%
Houston	18.70%	18.20%	4.10%	7.60%	7.90%	11.30%	3	6.0%	53%
New Orleans	8.10%	5.20%	3.20%	4.60%	5.10%	5.24%	5	1.6%	31%

4.2 Quantitative results

As explained in methodology section, quantitative results weren"t obtained through the questionnaire as the study of a city and port administration needed to also have precise quantifiable results on criterions that were of quantitative nature. Those criterions are: total TEU, export grain TEU, empty container availability, logistics cluster size, free trade zone size, quantity of logistics jobs, road weight restrictions, road congestion, size of trucking industry, land cost per acre, construction cost per square foot, state tax rate, median wages, unemployment rate, business climate, education level and state incentives.

4.2.1 Alternatives

In this section, each quantitative criterion in respect to its alternative along with its score will be explained separately, one at a time. The complete dataset can be found in Appendix 23 and 24.

Total TEU

Total TEU data was obtained from the American Association of Port Authorities (see Appendix 4). 2013 data was used for scoring purposes. The port of Los Angeles and Long Beach were aggregated for the Los Angeles area and the port of Seattle and Tacoma was aggregated for the Seattle area. As seen in Table 21, the Los Angeles area has a significant lead over the other ports with a share of almost 65% followed by Seattle, Hampton Roads, Houston and lastly New Orleans

Table 21 Alternative results for total TEU criteria

Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Total TEU	14599145	3461672	2223532	1950071	451058
Normalized in %	**64.35%**	**15.26%**	**9.80%**	**8.60%**	**1.99%**

Export Grain TEU

Export Grain TEU was obtained from Vachal 2014 (see Appendix 2). 2012 data was used for scoring purposes. Los Angeles and Seattle ports have been aggregated in the lower table (see Table 22). As with Total TEU, similar results have been found in regards to Export Grain TEU. Port of Los Angeles leads the way with a share of almost 61% followed by Seattle, Hampton Roads, Houston and New Orleans.

Table 22 Alternative results for export grain TEU criteria

Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Export Grain TEU	134393	43823	35243	6985	981
Normalized in %	**60.69%**	**19.79%**	**15.92%**	**3.15%**	**0.44%**

Empty container availability

Data was taken from the Agricultural Marketing Service of The United States Department of Agriculture. The data represents an average weekly snapshot of containers based on a dataset from June 2015-November 2015 (see Appendix 19). The data is obtained from member carriers in the Transpacific Stabilization Agreement (TSA). The TSA carriers include COSCO, Evergreen, Hanjin Shipping, Hapag Lloyd, Yang Ming Transport Corporation, and OOCL. Only 20ft dry containers we considered. A drawback and short coming of this is that Ray-Mont Logistics could technically load 40" containers if 20" are not available and if export price is similar. Furthermore, the three largest carriers such as MSC, Maersk and CMA are not members of the TSA and the data is thus not very representative. As seen in Table 23, the Port of Los Angeles leads the way with a share of almost 72% followed by Hampton Roads, Houston, New Orleans and Seattle. Seattle being the big upset is mainly due to the three main carriers not being part of the data. Unfortunately, the data from the big three carriers is maintained private.

Table 23 Alternative results for empty container availability criteria

Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Empty container availability (only 20')	3827	172	338	738	246
Normalized in %	**71.92%**	**3.23%**	**6.35%**	**13.87%**	**4.62%**

Logistics cluster size

Data on port districts and city"s logistics cluster size was scarce. This criteria was measured by averaging the results by state and in the following four categories: value of freight shipments in millions $ (2007), rail shipments terminating in state in tons (2011), waterborne shipments in thousands of short tons (2012) and, airfreight and mail in short tons (2012). The data was retrieved from the United States Department of Transportation"s Bureau of Transportation"s Statistics. Since four sub categories were chosen, the average of the average will be taken for the final score of this category (Overall score for Logistics cluster size). In this category (see Table 24), Houston leads the way with an overall score of 35.14%, just beating Los Angeles by a thin hair (34.49%). Next in line is New Orleans followed by Hampton Roads and then Seattle. In terms of value of freight and airfreight, we can assume Los Angeles handles a lot of high value freight and Houston with the petrol industry leads the pack with a high value of freight, rail and waterborne shipments.

Table 24 Alternative results for logistics cluster size criteria

Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Logistics cluster size (value of freight shipments in millions $)	$ 1,341,220.00	$ 215,515.00	$ 194,444.00	$ 1,166,608.00	$ 269,932.00
Normalized in %	**42.07%**	**6.76%**	**6.10%**	**36.60%**	**8.47%**
Logistics cluster size (rail shipments terminating in state in tons)	97407000	48842000	77572000	202425000	36867000
Normalized in %	**21.03%**	**10.55%**	**16.75%**	**43.71%**	**7.96%**
Logistics cluster size (waterbourne shipments in thousands of short tons)	220836	115598	79821	485884	510788
Normalized in %	**15.63%**	**8.18%**	**5.65%**	**34.39%**	**36.15%**
Logistics cluster size (airfreight and mail in short tons)	1864764.43	254237.65	174007.62	815138.23	41221.06
Normalized in %	**59.21%**	**8.07%**	**5.53%**	**25.88%**	**1.31%**
Overall score for Logistics cluster size	**34.49%**	**8.39%**	**8.51%**	**35.14%**	**13.47%**

Free trade zone size

Data was taken from the 76th Annual Report of the Foreign-Trade Zones Board to the Congress of the United States, 2014. The size of the Free trade zone is measured by the number of employed people in the FTZ in a given state. In theory, the larger the number of employed people in a FTZ, the larger the FTZ. Only port centric locations data was used. The data was given as a bracket range of +/- 1000 employees; the middle number was used as a final value. As seen in Table 25, Houston leads the way due to its large processing of heavy machinery and oil related equipment and products. Los Angeles then follows taking the remainder chunk of jobs, also relying heavily on oil related equipment. Next in line is Hampton Roads followed by New Orleans and then Seattle.

Table 25 Alternative results for free trade zone size criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Free trade zone size (people employed)	9000	1500	3500	15500	2750
Normalized in %	**27.91%**	**4.65%**	**10.85%**	**48.06%**	**8.53%**

Quantity of logistics jobs

Data was taken from U.S. Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School. The dataset is named Local logistical Services and composed of jobs in the following categories: Local passenger transportation, local transportation services, warehousing services, truck leasing and passenger car rental. Data is from 2013. The definition of logistics jobs varies quite a bit. The data couldn"t omit local passenger transportation and passenger car rental which would have been more representative. In any case, Los Angeles leads this category which is in line with the total amount of TEU, FTZ size and the logistics cluster size categories. However, as seen in table 26, Houston, trailing is second place would have been expected to have a higher score. Next in line are Seattle, New Orleans and Hampton Roads.

Table 26 Alternative results for quantity of logistics jobs criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Quantity of logistics jobs	126285	28672	9199	38584	10786
Normalized in %	**59.14%**	**13.43%**	**4.31%**	**18.07%**	**5.05%**

Road weight restrictions

Since 1998, state weight restrictions are governed by a maximum allowed in a given state and by the bridge gross weight formula. Figures were taken from Zim"s road weight regulations per state. In general most states allow a maximum gross weight (truck, trailer and cargo) of 80,000lbs but some states have special permits which allow a higher weight. Furthermore, the bridge formula takes into consideration the truck weight, the number of axels and the spread between the axels. Varying specs will allow more or less cargo to be carried on the road such as using lighter trucks and aluminum trailers would allow a higher payload in a container. Lastly, the data considered 20" containers, on a tri-axel trailer and if the state allowed a special permit, the higher weight limitation was considered. As seen in table 27, Los Angeles, Seattle and Houston allow a maximum weight of 44,000lbs in contrast to Hampton Roads and New Orleans which allow with the use of a special permit another 2,000lbs on the road.

Table 27 Alternative results for road weight restrictions criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Road weight restrictions	44000	44000	46000	44000	46000
Normalized in %	**19.64%**	**19.64%**	**20.54%**	**19.64%**	**20.54%**

Road congestion

Road congestion is measured by the travel time index which is a measure of congestion that focuses on each trip and each mile of travel. It is calculated as the ratio of travel time in the peak period to travel time in free-flow. A value of 1.30 indicates that a 20-minute free-flow trip takes 26 minutes in the peak. Dataset is from 2014 and was obtained from the INRIX Urban Mobility Scorecard Annual Report. As seen in Table 28, all five cities have a congestion level higher than one. Los Angeles being the most congested followed by Seattle, Houston, New Orleans and Hampton Roads.

Table 28 Alternative results for road congestion criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Road congestion (average % delay of a trip vs no congestion)	1.43	1.38	1.19	1.33	1.32
inverted result (a smaller value gives a higher score)	0.699300699	0.724638	0.840336134	0.7518797	0.757575758
Normalized in %	**18.53%**	**19.20%**	**22.27%**	**19.92%**	**20.07%**

Size of trucking industry

Data was taken from U.S. Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School. The dataset is named Transportation and Logistics and composed of jobs in the following categories: Air transportation, Specialty air transportation, Ground transportation support activities, trucking and bus transportation. Data is from 2013. The same comments apply as in the “quantity of logistics jobs” category higher-up. Not surprisingly and as seen in table 29, Los Angeles leads the way followed by Houston, Seattle, New Orleans and Hampton Roads.

Table 29 Alternative results for size of trucking industry criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Size of trucking industry	89279	25836	4992	48556	6570
Normalized in %	**50.95%**	**14.74%**	**2.85%**	**27.71%**	**3.75%**

Land cost per acre

Data was taken from a study on New Estimates of Value of Land of the United States from Larson (2015) for the U.S. Bureau of Economic Analysis. The value per acre is obtained by dividing the total worth of all the land by the quantity of acres. Values are per state since data wasn"t easily obtainable per city. As seen in table 30, Texas being the largest US state probably has a low value per acre as it devotes about 75% of its land to agriculture whereas the average state devotes only 47%. On the other side of the spectrum, California is the most expensive on a per acre basis probably due to its land being 53% federally owned and leaving the remainder land being highly sought after due to costal real estate prices.

Table 30 Alternative results for land cost per acre criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Land cost per acre	39091	16751	21921	7542	12908
inverted result (a smaller value gives a higher score)	2.55813E-05	6E-05	4.56184E-05	0.000133	7.74713E-05
Normalized in %	**7.50%**	**17.51%**	**13.38%**	**38.89%**	**22.72%**

Construction cost per square foot

Data was taken from the Craftsman 2015 national building cost manual. The data retained represents the price index when compared to the national averages for metropolitan areas of the United States and is based on residential, commercial, industrial, public, agricultural and military buildings. Each metropolitan area is based on the average of its port administration. If we take per example Seattle, the port administration is Seattle and Tacoma. The value in table 31 is the average index of the two port administrations. Results are relatively similar except for Hampton Roads which most probably beneficiates from lower construction wages due to a higher number of construction workers.

Table 31 Alternative results for construction cost per square foot criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Construction cost per square foot (price index to national average)	109%	107.5%	98%	112%	102%
inverted result (a smaller value gives a higher score)	92%	93%	102%	89%	98%
Normalized in %	**19.35%**	**19.62%**	**21.52%**	**18.83%**	**20.68%**

State tax rate

The state tax rate varies from one state to the other. However, Nevada, Ohio, Texas, and Washington do not have corporate income taxes but do have gross receipts taxes with rates not strictly comparable to corporate income tax rates. Delaware and Virginia have gross receipts taxes in addition to their corporate income taxes. This makes the metric hard to compare between the five different states. Data was obtained from the Tax Foundation, State Corporate Income Tax Rates and Brackets for 2015 (see Table 32).

Table 32 Alternative results for state tax rate criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
State tax rate	8.84%	0%	6%	0%	8%
inverted result (a smaller value gives a higher score)	1131.22 %	1000000 .00%	1666.67%	1000000 .00%	1250.00 %
Normalized in %	**0.06%**	**49.90%**	**0.08%**	**49.90%**	**0.06%**

Median wages

Median wages data was obtained from the United States Census Bureau website and is based on five year estimates from 2010-2014 (see Table 33). Median wages between the five cities vary in excess of 100% whereas Houston has the lowest median wage at $32855 and Seattle having the highest wages at $67365.

Table 33 Alternative results for median wages criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Median wages	$ 55,870.00	$ 67,365.00	$ 44,150.00	$ 32,855.00	$ 36,964.00
inverted result (a smaller value gives a higher score)	1.78987E-05	1.48445E-05	2.26501E-05	3.04368E-05	2.70533E-05
Normalized in %	**16%**	**13%**	**20%**	**27%**	**24%**

Unemployment rate

The unemployment rate represents the sum of all the population 16 years and older which is currently unemployed but has worked in the last year and that is currently unemployed and has not worked in the last 1-5 years. The data was obtained on the United States Census Bureau website and is based on five year estimates from 2006-2010 (see Table 34). The general hypothesis in this category is that the higher the unemployment rate, the better it is for a company coming into the city to hire employees.

Table 34 Alternative results for unemployment rate criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Unemployment rate	7.2%	6.1%	8.2%	5.9%	7%
Normalized in %	**20.93%**	**17.73%**	**23.84%**	**17.15%**	**20.35%**

Business climate

The business climate ranking was taken from: “Forbes' 2015 List Of The Best Places For Business And Careers”. Forbes looked at the 200 largest metro areas by population in the U.S. They were rated on a dozen factors related to employment, costs (business and living), income growth, quality of life and the education of the labor force. Forbes used data from Moody"s Analytics, demographer Bert Sperling, which runs Sperling"s Best Places and the U.S. Census. Norfolk (Hampton Roads) wasn"t analysed for Virginia and Virginia Beach being the closest city was considered an in lieu of Norfolk. These results (see Table 35) should be used with caution as Seattle came in 6th place but is in 149th place in cost of doing business, 37th place in job growth and 13th place in education, whereas, Houston came in 142nd place in cost of doing business, 10th place in job growth and 81st in education.

Table 35 Alternative results for business climate criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Business climate	116	6	90	45	98
inverted result (a smaller value gives a higher score)	0.0086	0.1667	0.0111	0.0222	0.0102
Normalized in %	**4%**	**76%**	**5%**	**10%**	**5%**

Education level

Education level data is based on the percent high school graduate or higher and was obtained on the United States Census Bureau website. It is based on five year estimates from 2010-2014. As we can see with the lower results (see table 36), Seattle has the most high school or higher graduates, 16% more than Los Angeles which has the lowest score of the five cities. This however only translates to a 3.9% difference between the two cities.

Table 36 Alternative results for education level criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Education level	76.8%	93.10%	86.60%	81.10%	84.80%
Normalized in %	**18.18%**	**22.04%**	**20.50%**	**19.20%**	**20.08%**

Local incentives

Local incentives were measured by the amount of corporate incentive programs offered by each state which are classified by 5 types: grants, tax credits, tax exemption, loan/loan participation and loan guarantee. Data was obtained from the State Business Incentives Database from the Council for Community and Economic Research. The hypothesis is that the more incentive programs offered in a city/state, the more attractive that city is in terms of economic incentives. As seen in table 37, Hampton Roads and Seattle have substantially more incentives than the other three cities. However, the value of the incentives and the relevance to Ray-Mont‟s industry has not been evaluated. Thus, a city with fewer incentives could potentially have more economically advantageous incentives to Ray-Mont Logistics.

Table 37 Alternative results for local incentives criteria

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Local incentives	22	49	62	33	31
Normalized in %	**11.17%**	**24.87%**	**31.47%**	**16.75%**	**15.74%**

4.3 Sample Calculation of the AHP Matrix

In this section, we will demonstrate how to calculate the values obtained by the AHP program developed by Klaus D. Goepel at Business Performance Management Singapore. The software uses the power method for approximating eigenvalues and eigenvectors. For this example, we will use the 3X3 matrix derived from respondent 1 under Transportation Advantage in appendix 14.

AHP matrix (A) from respondent 1, Transportation advantage

$$\begin{bmatrix} 1 & 6 & 8 \\ 0.166667 & 1 & 2 \\ 0.125 & 0.5 & 1 \end{bmatrix}$$

The first step is to find the eigenvalue. In order to do this, we begin with a nonzero approximation of (1,1,1) and repeat the iteration 7 times which gives the following.

	Iteration								**Approximation**		
x_1	1	6	8	1	=	15	→	1.625	9.230769231
	0.166667	1	2	1		3.166667			1.948717949
	0.125	0.5	1	1		1.625			1
x_2	1	6	8	15	=	47	→	5.083333	9.245901639
	0.166667	1	2	3.166667		8.916667			1.754098361
	0.125	0.5	1	1.625		5.083333			1
x_3	1	6	8	47	=	141.1667	→	15.41667	9.156756757
	0.166667	1	2	8.916667		26.91667			1.745945946
	0.125	0.5	1	5.083333		15.41667			1
x_4	1	6	8	141.1667	=	426	→	46.52083	9.15718764
	0.166667	1	2	26.91667		81.27778			1.747126437
	0.125	0.5	1	15.41667		46.52083			1

$$x_5 \begin{bmatrix} 1 & 6 & 8 \\ 0.166667 & 1 & 2 \\ 0.125 & 0.5 & 1 \end{bmatrix} \begin{bmatrix} 426 \\ 81.27778 \\ 46.52083 \end{bmatrix} = \begin{bmatrix} 1285.833 \\ 245.3194 \\ 140.4097 \end{bmatrix} \quad 140.4097 \begin{bmatrix} 9.157722934 \\ 1.747168505 \\ 1 \end{bmatrix}$$

$$x_6 \begin{bmatrix} 1 & 6 & 8 \\ 0.166667 & 1 & 2 \\ 0.125 & 0.5 & 1 \end{bmatrix} \begin{bmatrix} 1285.833 \\ 245.3194 \\ 140.4097 \end{bmatrix} = \begin{bmatrix} 3881.028 \\ 740.4444 \\ 423.7986 \end{bmatrix} \rightarrow 423.7986 \begin{bmatrix} 9.157717076 \\ 1.747161093 \\ 1 \end{bmatrix}$$

$$x_7 \begin{bmatrix} 1 & 6 & 8 \\ 0.166667 & 1 & 2 \\ 0.125 & 0.5 & 1 \end{bmatrix} \begin{bmatrix} 3881.028 \\ 740.4444 \\ 423.7986 \end{bmatrix} = \begin{bmatrix} 11714.08 \\ 2234.88 \\ 1279.149 \end{bmatrix} \rightarrow 1279.149 \begin{bmatrix} 9.157713867 \\ 1.747160883 \\ 1 \end{bmatrix}$$

After the 7th iteration of the power method, X = (9.157713867, 1.747160883, 1) as our approximation of a dominant eigenvector of the matrix (A), we use the Rayleigh quotient to obtain an approximation of the dominant eigenvalue of (A). We then need to compute the product of Ax.

$$A_x \begin{bmatrix} 1 & 6 & 8 \\ 0.166667 & 1 & 2 \\ 0.125 & 0.5 & 1 \end{bmatrix} \begin{bmatrix} 9.157714 \\ 1.747161 \\ 1 \end{bmatrix} = \begin{bmatrix} 27.64068 \\ 5.273447 \\ 3.018295 \end{bmatrix}$$

Then, since

Ax * x * x = (9.157714 * 27.64068) + (1.747161 * 5.273447) + (1 * 3.018295) = 256.3573

And

x * x * x = (9.157714 * 9.157714) + (1.747161 * 1.747161) + (1 * 1) = 87.91629

We compute the Rayleigh quotient to be

λ = (Ax * x * x) / (x * x * x) = 256.3573 / 87.91629 = 3.018295

Once we have obtained the eigenvalue of 3.018295, we have to find the eigenvectors.

We then get the following matrix equation:

$$\begin{bmatrix} 1 & 6 & 8 \\ 0.166667 & 1 & 2 \\ 0.125 & 0.5 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = 3.018295 \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

Which yields the following equations:

x + 6y + 8z = 3.018295x

1/6y + y + 2z = 3.018295y

1/8x + 0.5y + z = 3.018295z

x + y + z = 1

By solving the equations we get:

X= 0.769

Y= 0.147

Z= 0.084

These results are exactly the same as the ones under Transportation Advantage in appendix 14.

5 Final verdict

In order to declare a winner and rank all the alternatives, the location factors results (1st hierarchy) in the AHP had to distribute its values to the criterions (2nd hierarchy) in the AHP and then redistribute the final values to the alternatives. In Appendix 25 under distributive priorities, the score indicated is the multiplication between the location factor results and the criterions. The values under the alternatives are the values that were obtained through the qualitative and quantitative analysis and which can be found in Appendixes 20-24. In Appendix 26 we can find the final scores which is the multiplication of the distributive priorities and alternative values found in Appendix 25.

As seen in Table 38, the results are quite mitigated as the race was very close between 3 of the alternatives. Seattle won with a final score of 26.9%, followed by Los Angeles 25%, Houston 22.5%, Hampton Roads 13.2% and lastly New Orleans 12.4% (see table 38). Roughly 74% of the score came from 50% or 3 location factors which are logistical activity, rail and seaway cost and transportation advantage.

Table 38 Final score of alternatives

	Synthesis of the priorities of the alternatives				
City	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Synthesis of overall priorities	25.07%	26.94%	13.19%	22.46%	12.42%
Priorities	2	1	4	3	5

Table 39 provides a summary and breakdown of the first three ranking port administrations by location factors. Table 40 was also created in order to show the contribution of location factors in respect to the final score to the first three ranking port administrations. Port attractiveness contributed about 23% to Los Angeles‟s final score whereas only 8% for Seattle and 5% for Houston. Logistical activity contributed about 25% to Los Angeles‟s final score whereas only 5% to Seattle and 26% to Houston. Rail and Seaway cost contributed about 18% to Los Angeles‟s final score whereas 50% to Seattle and 20% to Houston. Transportation advantage contributed about 29% to Los Angeles‟s final score whereas 22% to Seattle and 29% to Houston. Economic costs contributed about 5% to Los Angeles‟s final score, 11% to Seattle and 19% to Houston. Lastly, local economy contributed about 1.5% to Los Angeles‟s final score, 5% to Seattle and 2% to Houston.

Table 39 Los Angeles, Seattle and Houston score distribution in regards to location factors weight

Location Factors	Weight	Los Angeles	Rank	Seattle	Rank	Houston	Rank
Port attractiveness	10.84%	5.73%	1	2.12%	2	1.13%	3
Logistical Activity	16.34%	6.09%	1	1.36%	3	5.81%	2
Rail and seaway cost	26.26%	4.46%	2	13.41%	1	4.44%	3
Transportation advantage	31.18%	7.16%	1	5.93%	3	6.42%	2
Economic costs	12.32%	1.28%	3	2.87%	2	4.20%	1
Local Economy	3.08%	0.35%	3	1.25%	1	0.46%	2

Table 40 location factors total score contribution to Los Angeles, Seattle and Houston

	Location Factors contribution to port administration					
Location Factors	Los Angeles	Rank	Seattle	Rank	Houston	Rank
Portuary attractiveness	22.87%	1	7.85%	2	5.05%	3
Logistical Activity	24.31%	1	5.06%	3	25.85%	2
Rail and seaway cost	17.78%	2	49.77%	1	19.75%	3
Transportation advantage	28.56%	1	22.02%	3	28.58%	2
Economic costs	5.09%	3	10.65%	2	18.69%	1
Local Economy	1.40%	3	4.65%	1	2.07%	2

6 Conclusion

In sum, Analytic Hierarchy Process (AHP) provided a framework to properly analyse the location problem tailored to Ray-Mont logistics and provided a fresh new way of conducting a multi-criteria decision making problem to a 3PL. AHP allowed the problem to be modulated by multi layering and clustering with the use of location factors, criterions and alternatives in order to find the best location. It also permitted to bring together quantitative and qualitative data with the use of one consice method and provided an unbiased canvas of evaluation with the use of pairwise comparisons and scoring technique. Location analysis is a very broad field of study which offers a plethora of evaluation techniques. Choosing the best method is quite subjective to the problem analysed and the type of data used as well as the level of complexity of the problem. Location analysis isn"t a perfect science due to a decision maker"s inability to foresee everything and factor every possible criteria. Furthermore, AHP is a complex method of analysis for an uninitialized person. It requires a lot of reading-up in order to understand how to use the method and a strong mathematical background. It also requires decision makers to develop a lengthy questionnaire that can sound mundane to the respondents who are generally not used to answer questions in a pairwise format. This can lead some respondents to become inconsistent with their responses and oblige the decision makers to slightly change the respondent"s questionnaire results when the coefficient ratio is larger than 10% (this is what the method prescribes). I personally would rather leave the responses untouched than altering the repondents responses.

Using the AHP technique proved essential in evaluating the U.S possible expansion for Ray-Mont Logistics. It allowed the decision makers to prioritize the location factors and criterias and obtain upper managements opinions and rank them through a questionnaire. It also allowed through quantitative analysis to quantify all the criteria"s values in respect to the alternatives and to compare and rank them accordingly. It was only found at the last possible moment who the winners were, no one could tell who that would be till the last calculations were made. One would have thought that a clear victor would have been named but as the study revealed a tight race between Seattle, Los Angeles and Houston was demonstrated by the final results, which were mitigated to say the least. This reinforces the notion that locating isn"t as easy as one would think and a lot of care has to go into selecting the best location. Even though the results are mitigated, the study proved essential to narrow the scope of locations, underline the important categories in the views of the respondents, provide a canvas for future research on this topic and allow the decision makers to understand the particularities

surrounding the location problem. Knowing this will allow the decision makers to properly align their priorities in regards to location analysis and broaden/narrow the scope of analysis.

6.1 Limitations

Finally, a number of important limitations and caveats need to be considered, notably in regards to:

1- An in depth microeconomic research of each port administration and their particularities which were not part of the scope of this research such as competitors, other markets/products, potential demand, etc. It is important to know who the direct competitors are, how they are tied into the supply chain, how they operate, their volumes, etc. At the same time, research needs to be conducted with linked commodities, i.e.: grain derived products such as distiller dried grains (DDG"s) which is a fast growing commodity in the U.S. and that Ray-Mont can easily take advantage with their current processes. In the same optic, non-related industries that require container loading or unloading (import and export commodities), such as metal, lumber, tiles, recycled products, pulp and paper, etc., need to be investigated. Furthermore, other criterions, such as local incentives as an example, need to be further investigated. The metric in the study was the more local incentive programs, the higher the score. This, however, has no fiscal relevance. A port administration that has the least incentives might have the highest fiscal impact over the others as they could pertain to Ray-Mont"s industry. Land cost per acre criteria is another example.

2- Adding the alternative city of Chicago in the study. Due to the lack of time and data, this was not possible. Chicago has a particular advantage as it is centrally located in the U.S.; it"s the largest inland port and has a rail link that spans to all seaway ports. Furthermore, Chicago ships a lot of grain and pulses to all the ports studied.

3- Obtaining up to date and reliable data on container shipments in regards to inland shipments, exports and imports. Complete recent key figures will enable decision makers to segregate the data. An example is the data obtained on grain shipments to say the port of Seattle, contained containers with an origin of Chicago. Obtaining data where one can control all OD pairs and commodities will provide a better understanding of the U.S. supply chain. Such data is obtainable with an expensive yearly subscription to PIERS.

4- Factoring in rail and seaway costs as quantitative data. In the study, this factor was of qualitative nature and was based on knowledge of the respondents. It is safe to assume that the respondents didn"t have enough in depth knowledge in regards to rail pricing and might not be familiar with export shipping prices from certain port administrations. This introduces two caveats, the first one is the absence of U.S. customers participating in the survey and the second is the absence of hard data in regards to shipping routes on export and inland rail costs with the use of OD pairs.

5- The sample size was limited to 5 respondents who all worked at Ray-Mont logistics. Initially there were 7, but 2 were removed due to lack of overall knowledge such as human resources. The small size of the sample highly impacts the overall score. In many instances, introduction of noise in the results when one or more respondents deviated from the others response impacted the final score of a category. This was probably due to a lack of knowledge in a certain category or a miscomprehension of the question on the behalf of a specific respondent. With 5 respondents, their weight is overall 20%. Bringing the respondents count to at least 20 or 5% impact would help alleviate the category results and diminish noise in regards to the results. Furthermore, including clients with an extensive U.S. shipping knowledge could highly influence the end result, notably in the rail and seaway cost category.

6- The exclusion of clients was decided internally for many reasons. In the past, the company has made many strategic decisions under the radar and only announced them once they were finalised. Because of this, it can be assumed that the company isn"t ready to announce to the industry that they are thinking of opening a terminal in the U.S. Furthermore, because the location is of strategic nature, the company does not necessarily want to alert the internal and external clients on where it plans to locate, which brings an element of surprise and removes all possibility of preparation; enabling Ray-Mont to shape its supply chain ahead of time.

6.2 Future Research

This study will be used as an introductory research of the location problem by Ray-Mont"s decision makers as there is much more work that can be done to broaden and

expand this field of study. Future research should include the city of Chicago as discussed in the limitations, which operates the largest inland port interconnecting the north, south, east and west of the U.S. with all the main rail carriers interconnecting into the city. Also, a more in depth analysis of commodities that are directly or indirectly related to containerisation such DDG"s and non-related to the grain industry with a particular attention to the microeconomic dimension of specific port administrations. Other particular dimensions to the microeconomic perspective which should be looked into are taxation, potential land costs and local incentives which need an in depth fiscal review. Corporate taxation in the U.S is a complicated matter and can make a huge difference in a corporation"s bottom line. Furthermore, the study of the U.S market, being a simple option due to its proximity to Ray-Mont"s current location should be broadened internationally. Other nations such as Australia, India, Brazil or Argentina to name a few, are large exporters of grain and might provide better opportunities in terms of market share and growth, technology advancements, commercial openness, corporate positioning, strategy, etc.; which could be a better pivot point for an accelerated expansion of the company. As described in the limitations, increasing the sample to at least 20 participants and having participants with in depth knowledge of the U.S. market would be highly beneficial for the study and would attenuate noise in the end result.

Appendix 1 U.S. Grain Containers Exports by Port, 2008-2012

U.S. Port District	U.S. Port	TEU
Los Angeles, CA	Los Angeles	535,524
Los Angeles, CA	Long Beach	462,153
Norfolk, VA	Norfolk	191,203
Seattle, WA	Tacoma	188,292
San Francisco, CA	Oakland	162,309
New York City, NY	New York	113,572
Seattle, WA	Seattle	107,315
Houston-Galveston, TX	Houston	33,399
Savannah, GA	Savannah	24,181
Tampa, FL	Jacksonville	17,627
Columbia-Snake, OR	Portland	12,900
Miami, FL	Miami	11,819
New Orleans, LA	New Orleans	7,045
Miami, FL	Pt Everglades	5,722
Charleston, SC	Charleston	4,513
Honolulu, HI	Honolulu	4,277
Miami, FL	W Palm Bch	4,201
Houston-Galveston, TX	Freeport	3,658
Baltimore, MD	Baltimore	3,584
Charlotte, NC	Wilmington	3,531
New Orleans, LA	Lk Charles	3,113
Philadelphia, PA	Philadelphia	1,863
Mobile, AL	Mobile	1,642
Mobile, AL	Gulfport	1,386
San Juan, PR	San Juan	957
Philadelphia, PA	Pennsauken	751
Tampa, FL	Tampa	539
Philadelphia, PA	Wilmington	246
Miami, FL	Ft Pierce	167
Norfolk, VA	Richmond	157
Tampa, FL	Panama City	105
Boston, MA	Boston	76
Philadelphia, PA	Salem	76
Philadelphia, PA	Chester	74
Columbia-Snake, OR	Vancouver	54
Norfolk, VA	Newport News	54

Source: Vachal, 2014

Appendix 2 U.S. Port District Grain Container Volumes, 2003-2012 TEU's

US Port District	Avg. 2003-2007	2008	2009	2010	2011	2012
Los Angeles, CA	87,849	266,692	237,008	171,090	188,501	134,393
Seattle, WA	53,465	113,913	62,392	37,782	37,697	43,823
Norfolk, VA	14,617	46,800	45,313	39,336	24,721	35,243
San Francisco, CA	16,543	38,672	47,346	28,806	24,482	23,010
New York City, NY	8,725	17,007	17,434	22,258	27,567	29,305
Houston-Galveston, TX	6,636	7,197	6,070	9,326	7,478	6,985
Savannah, GA	1,032	7,716	5,854	4,743	2,805	3,063
Miami, FL	3,845	5,853	5,350	4,097	3,086	3,524
Tampa, FL	3,886	3,215	4,433	4,223	3,344	3,087
Columbia-Snake, OR	3,304	3,449	3,388	2,733	1,811	1,574
New Orleans, LA	2,822	2,188	3,094	2,726	1,168	981
Charleston, SC	1,253	855	794	1,335	716	813
Honolulu, HI	316	1,058	701	645	856	1,017
Baltimore, MD	536	940	726	582	363	973
Charlotte, NC	88	690	867	1,054	262	662
Philadelphia, PA	860	610	675	861	584	306
Mobile, AL	391	786	999	516	347	379
San Juan, PR	350	398	245	209	100	36
Boston, MA	3	2	3	21	23	28
Anchorage, AK	-	-	-	-	6	20
San Diego, CA	2	6	-	4	8	2
Port Arthur, TX	-	-	-	-	0	6
Portland, ME	0	-	-	-	-	-

Source: Vachal, 2014

Appendix 3 Top 20 U.S. Ports Moving Waterborne Agricultural Trade, 2011

Top 20 U.S. Ports Moving Waterborne Agricultural Trade, 2011						
Rank	U.S. Ports	State	Imports	Exports	Total	Share
			Metric Tons			
1	New Orleans Port Region*	LA	1,905,984	59,716,467	61,622,450	33%
2	Los Angeles	CA	2,725,490	7,666,611	10,392,101	6%
3	Kalama	WA	-	9,504,198	9,504,198	5%
4	New York	NY	7,979,024	1,463,135	9,442,159	5%
5	Houston	TX	1,796,448	7,425,281	9,221,729	5%
6	Seattle	WA	553,031	8,348,638	8,901,669	5%
7	Tacoma	WA	110,408	7,295,856	7,406,264	4%
8	Portland	OR	85,320	6,741,356	6,826,677	4%
9	Long Beach	CA	1,925,664	4,467,843	6,393,507	3%
10	Oakland	CA	2,038,008	4,221,872	6,259,880	3%
11	Norfolk*	VA	1,109,023	4,905,642	6,014,665	3%
12	Savannah	GA	2,466,994	2,066,933	4,533,927	2%
13	Corpus Christi	TX	39,385	4,068,528	4,107,913	2%
14	Galveston	TX	298,841	3,343,325	3,642,166	2%
15	Vancouver	WA	-	3,403,622	3,403,622	2%
16	Philadelphia	PA	2,315,106	146,635	2,461,741	1%
17	Port Everglades	FL	1,276,241	580,704	1,856,945	1%
18	Beaumont	TX	47,078	1,658,354	1,705,432	1%
19	Jacksonville	FL	377,372	1,287,109	1,664,482	1%
20	Miami	FL	992,432	602,986	1,595,418	1%
	Other		12,684,456	7,564,934	20,249,390	11%
	Total		40,726,304	146,480,029	187,206,333	100%

*New Orleans Port Region includes: South Louisiana, New Orleans, Westwego, Baton Rouge, Avondale, Gretna, Chalmette, Gramercy, Destrehan, LA *Norfolk includes: Norfolk, Newport News, and Richmond, VA

Source: Agricultural Marketing Service of the United States Department of Agriculture

Appendix 4 NORTH AMERICA: CONTAINER PORT TRAFFIC IN TEUs

NORTH AMERICA: CONTAINER PORT TRAFFIC IN TEUs						
	2013	2012	2011	2010	2009	2008
Los Angeles	7,868,572	8,077,714	7,940,511	7,831,902	6,748,995	7,849,985
Long Beach	6,730,573	6,045,662	6,061,091	6,263,499	5,067,597	6,350,125
New York/New Jersey	5,467,345	5,529,913	5,503,485	5,292,025	4,561,528	5,265,058
Savannah	3,034,010	2,966,213	2,944,678	2,825,179	2,356,512	2,616,126
Oakland	2,346,460	2,254,595	2,342,504	2,330,214	2,050,030	2,236,244
Hampton Roads (VA)	2,223,532	2,105,886	1,918,029	1,895,017	1,745,228	2,083,278
Houston	1,950,071	1,922,529	1,866,450	1,817,169	1,797,198	1,795,320
Tacoma	1,886,678	1,717,695	1,485,617	1,455,466	1,545,853	1,861,352
Charleston	1,601,366	1,514,585	1,381,352	1,364,504	1,181,353	1,635,534
Seattle	1,574,994	1,885,680	2,033,535	2,133,548	1,584,596	1,704,492
San Juan (FY)	1,269,902	1,423,192	1,484,595	1,525,532	1,673,745	1,684,883
Honolulu (FY)	1,078,341	1,187,024	938,821	968,326	1,049,420	1,124,388
Port Everglades (FY)	927,544	923,600	880,999	793,227	796,160	985,095
Jacksonville (a) (FY)	926,810	923,612	900,433	826,580	754,352	697,494
Miami (FY)	901,454	909,197	906,607	847,249	807,069	828,349
Anchorage	739,628	454,777	423,381	445,814	467,880	544,325
Baltimore	705,230	678,262	631,804	610,922	525,296	612,877
New Orleans (a)	451,058	464,834	477,363	427,518	325,857	235,324
Philadelphia	367,499	273,190	291,091	272,824	222,900	255,128
Wilmington(DE)	329,200	299,180	272,996	263,040	259,964	267,684
Wilmington(NC)	260,363	270,792	287,469	265,074	225,176	196,040
Palm Beach (FY)	254,664	228,438	212,008	213,286	199,393	244,638

***>250000TEU 2013**

Source: American Association of Port Authorities

HEC MONTRÉAL

Retrait d’une ou des pages pouvant contenir des renseignements personnels

The objective of this study is to help Ray-Mont logistics gain insight on a possible grain transloading terminal expansion in the United States. We are asking participants to rank location factors, criteria and alternatives in pairs on a scale of 1 to 9. A score of 1 means both items are equally important and at the other end of the spectrum, a score of 9 means one item is extremely more important than the other. Furthermore, we are also asking you to tell us which of the two compared items are more important by circling the answer. The two items we are asking to compare are identified in bold text in each question. If the two items compared have a rank of 1, it"s because they are equally important. In this case circle both answers in bold. Please refer to table 1 for a description of the ranking definitions. A description of the criteria which will be qualified under the location factors will be provided to further clarify what the location factors entails (see appendix 6) and should be used as a reference during the questionnaire.

Table 1

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another.
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another.
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance is demonstrated in practice.
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
1.1–1.9	When activities are very close a decimal is added to 1 to show their difference as appropriate.	A better alternative way to assigning the small decimals is to compare two close activities with other widely contrasting ones, favoring the larger one a little over the smaller one when using the 1–9 values.
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	This is logical assumption.
Measurements from ratio scales		When it is desired to use such numbers in physical applications; alternatively, often one estimates the ratios of such magnitudes by using judgment.

An example of question 1

Q1- Which location factor between **port attractiveness** and **logistical activity** is more important and by what degree?

If you circled port attractiveness and scored a 9. This means that port attractiveness is in your opinion extremely more important in terms of location compared to logistical activity.

Questionnaire for the evaluation hierarchical structure of a grain terminal selection. Ranking location factors (part 1)

Q1- Which location factor between **port attractiveness** and **logistical activity** is more important and by what degree?

Q2- Which location factor between **port attractiveness** and **rail and seaway cost** is more important and by what degree?

Q3- Which location factor between **port attractiveness** and **transportation advantage** is more important and by what degree?

Q4- Which location factor between **port attractiveness** and **economic costs** is more important and by what degree?

Q5- Which location factor between **port attractiveness** and **local economy** is more important and by what degree?

Q6- Which location factor between **logistical activity** and **rail and seaway cost** is more important and by what degree?

Q7- Which location factor between **logistical activity** and **transportation advantage** is more important and by what degree?

Q8- Which location factor between **logistical activity** and **economic costs** is more important and by what degree?

Q9- Which location factor between **logistical activity** and **local economy** is more important and by what degree?

Q10- Which location factor between **rail and seaway cost** and **transportation advantage** is more important and by what degree?

Q11- Which location factor between **rail and seaway cost** and **economic costs** is more important and by what degree?

Q12- Which location factor between **rail and seaway cost** and **local economy** is more important and by what degree?

Q13- Which location factor between **transportation advantage** and **economic costs** is more important and by what degree?

Q14- Which location factor between **transportation advantage** and **local economy** is more important and by what degree?

Q15- Which location factor between **economic costs** and **local economy** is more important and by what degree?

Questionnaire for the evaluation hierarchical structure of a grain terminal selection. Ranking criteria (part 2)

Q1- Thinking of port attractiveness, which criteria between **total TEU** and **export grain TEU** is more important and by what degree?

Q2- Thinking of port attractiveness, which criteria between **total TEU** and **empty container availability** is more important and by what degree?

Q3- Thinking of port attractiveness, which criteria between **total TEU** and **flexibility** is more important and by what degree?

Q4- Thinking of port attractiveness, which criteria between **total TEU** and **long term growth of business** is more important and by what degree?

Q5- Thinking of port attractiveness, which criteria between **export grain TEU** and **empty container availability** is more important and by what degree?

Q6- Thinking of port attractiveness, which criteria between **export grain TEU** and **flexibility** is more important and by what degree?

Q7- Thinking of port attractiveness, which criteria between **export grain TEU** and **long term growth of business** is more important and by what degree?

Q8- Thinking of port attractiveness, which criteria between **empty container availability** and **flexibility** is more important and by what degree?

Q9- Thinking of port attractiveness, which criteria between **empty container availability** and **long term growth of business** is more important and by what degree?

Q10- Thinking of port attractiveness, which criteria between **flexibility** and **long term growth of business** is more important and by what degree?

Q11- Thinking of logistical activity, which criteria between **logistics cluster size** and **free trade zone size** is more important and by what degree?

Q12- Thinking of logistical activity, which criteria between **logistics cluster size** and **quantity of logistics jobs** is more important and by what degree?

Q13- Thinking of logistical activity, which criteria between **free trade zone size** and **quantity of logistics jobs** is more important and by what degree?

Q14- Thinking of rail and seaway cost, which criteria between **rail cost** and **export container cost** is more important and by what degree?

Q15- Thinking of transportation advantage, which criteria between **road weight restrictions** and **road congestion** is more important and by what degree?

Q16- Thinking of transportation advantage, which criteria between **road weight restrictions** and **size of trucking industry** is more important and by what degree?

Q17- Thinking of transportation advantage, which criteria between **road congestion** and **size of trucking industry** is more important and by what degree?

Q18- Thinking of economic costs, which criteria between **land cost per acre** and **construction cost per square foot** is more important and by what degree?

Q19- Thinking of economic costs, which criteria between **land cost per acre** and **state tax rate** is more important and by what degree?

Q20- Thinking of economic costs, which criteria between **land cost per acre** and **median wages** is more important and by what degree?

Q21- Thinking of economic costs, which criteria between **construction cost per square foot** and **state tax rate** is more important and by what degree?

Q22- Thinking of economic costs, which criteria between **construction cost per square foot** and **median wages** is more important and by what degree?

Q23- Thinking of economic costs, which criteria between **state tax rate** and **median wages** is more important and by what degree?

Q24- Thinking of the local economy, which criteria between **unemployment rate** and **business climate** is more important and by what degree?

Q25- Thinking of the local economy, which criteria between **unemployment rate** and **education level** is more important and by what degree?

Q26- Thinking of the local economy, which criteria between **unemployment rate** and **state incentives** is more important and by what degree?

Q27- Thinking of the local economy, which criteria between **business climate** and **education level** is more important and by what degree?

Q28- Thinking of the local economy, which criteria between **business climate** and **state incentives** is more important and by what degree?

Q29- Thinking of the local economy, which criteria between **education level** and **state incentives** is more important and by what degree?

Questionnaire for the evaluation hierarchical structure of a grain terminal selection. Ranking alternatives (part 3)

Q1- In terms of flexibility, which alternative (port district) between **Los Angeles** and **Seattle** offers you the most flexibility and by what degree?

Q2- In terms of flexibility, which alternative (port district) between **Los Angeles** and **Norfolk** offers you the most flexibility and by what degree?

Q3- In terms of flexibility, which alternative (port district) between **Los Angeles** and **Houston** offers you the most flexibility and by what degree?

Q4- In terms of flexibility, which alternative (port district) between **Los Angeles** and **New Orleans** offers you the most flexibility and by what degree?

Q5- In terms of flexibility, which alternative (port district) between **Seattle** and **Norfolk** offers you the most flexibility and by what degree?

Q6- In terms of flexibility, which alternative (port district) between **Seattle** and **Houston** offers you the most flexibility and by what degree?

Q7- In terms of flexibility, which alternative (port district) between **Seattle** and **New Orleans** offers you the most flexibility and by what degree?

Q8- In terms of flexibility, which alternative (port district) between **Norfolk** and **Houston** offers you the most flexibility and by what degree?

Q9- In terms of flexibility, which alternative (port district) between **Norfolk** and **New Orleans** offers you the most flexibility and by what degree?

Q10- In terms of flexibility, which alternative (port district) between **Houston** and **New Orleans** offers you the most flexibility and by what degree?

Q11- In terms of long term growth of business, which alternative (port district) between **Los Angeles** and **Seattle** has the most potential and by what degree?

Q12- In terms of long term growth of business, which alternative (port district) between **Los Angeles** and **Norfolk** has the most potential and by what degree?

Q13- In terms of long term growth of business, which alternative (port district) between **Los Angeles** and **Houston** has the most potential and by what degree?

Q14- In terms of long term growth of business, which alternative (port district) between **Los Angeles** and **New Orleans** has the most potential and by what degree?

Q15- In terms of long term growth of business, which alternative (port district) between **Seattle** and **Norfolk** has the most potential and by what degree?

Q16- In terms of long term growth of business, which alternative (port district) between **Seattle** and **Houston** has the most potential and by what degree?

Q17- In terms of long term growth of business, which alternative (port district) between **Seattle** and **New Orleans** has the most potential and by what degree?

Q18- In terms of long term growth of business, which alternative (port district) between **Norfolk** and **Houston** has the most potential and by what degree?

Q19- In terms of long term growth of business, which alternative (port district) between **Norfolk** and **New Orleans** has the most potential and by what degree?

Q20- In terms of long term growth of business, which alternative (port district) between **Houston** and **New Orleans** has the most potential and by what degree?

Q21- In terms of rail cost, which alternative (port district) between **Los Angeles** and **Seattle** are you more inclined to ship railcars to and by what degree?

Q22- In terms of rail cost, which alternative (port district) between **Los Angeles** and **Norfolk** are you more inclined to ship railcars to and by what degree?

Q23- In terms of rail cost, which alternative (port district) between **Los Angeles** and **Houston** are you more inclined to ship railcars to and by what degree?

Q24- In terms of rail cost, which alternative (port district) between **Los Angeles** and **New Orleans** are you more inclined to ship railcars to and by what degree?

Q25- In terms of rail cost, which alternative (port district) between **Seattle** and **Norfolk** are you more inclined to ship railcars to and by what degree?

Q26- In terms of rail cost, which alternative (port district) between **Seattle** and **Houston** are you more inclined to ship railcars to and by what degree?

Q27- In terms of rail cost, which alternative (port district) between **Seattle** and **New Orleans** are you more inclined to ship railcars to and by what degree?

Q28- In terms of rail cost, which alternative (port district) between **Norfolk** and **Houston** are you more inclined to ship railcars to and by what degree?

Q29- In terms of rail cost, which alternative (port district) between **Norfolk** and **New Orleans** are you more inclined to ship railcars to and by what degree?

Q30- In terms of rail cost, which alternative (port district) between **Houston** and **New Orleans** are you more inclined to ship railcars to and by what degree?

Q31- In terms of export container cost, which alternative (port district) between **Los Angeles** and **Seattle** are you more inclined to ship out from and by what degree?

Q32- In terms of export container cost, which alternative (port district) between **Los Angeles** and **Norfolk** are you more inclined to ship out from and by what degree?

Q33- In terms of export container cost, which alternative (port district) between **Los Angeles** and **Houston** are you more inclined to ship out from and by what degree?

Q34- In terms of export container cost, which alternative (port district) between **Los Angeles** and **New Orleans** are you more inclined to ship out from and by what degree?

Q35- In terms of export container cost, which alternative (port district) between **Seattle** and **Norfolk** are you more inclined to ship out from and by what degree?

Q36- In terms of export container cost, which alternative (port district) between **Seattle** and **Houston** are you more inclined to ship out from and by what degree?

Q37- In terms of export container cost, which alternative (port district) between **Seattle** and **New Orleans** are you more inclined to ship out from and by what degree?

Q38- In terms of export container cost, which alternative (port district) between **Norfolk** and **Houston** are you more inclined to ship out from and by what degree?

Q39- In terms of export container cost, which alternative (port district) between **Norfolk** and **New Orleans** are you more inclined to ship out from and by what degree?

Q40- In terms of export container cost, which alternative (port district) between **Houston** and **New Orleans** are you more inclined to ship out from and by what degree?

Appendix 6 **Location factors and criteria description**

1- Port Attractiveness: Decision factors that dictate why certain companies establish themselves around that port and/or why companies ship through that port. Mainly strategic and competitive advantages. Subject to the five following criteria.

   1.1- Total TEU: Total quantity of TEU handled from the port (import and export).
   1.2- Export Gain TEU: Total quantity of grain and agriculture containers exported through the port.
   1.3- Empty Container Availability: Quantity and availability of containers accessible at the port
   1.4- Flexibility: Degree of flexibility the port allows your company to ship to various international markets
   1.5- Long Term Growth of Business: Level of confidence the port will allow you to grow your business on a long term forecast (5-10y).

2- Logistical Activity: Level of logistical activity generated in and around a port. Value proposition in terms of shipping options, competition among suppliers, quality and quantity of suppliers, etc. Subject to the three following criteria.

   2.1- Logistics Cluster Size: geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries and associated institutions.

   2.2- Free Trade Zone Size: Geographic area where goods may be landed, handled, manufactured or reconfigured, and re-exported without the intervention of the customs authorities and having to pay customs duties.

   2.3- Quantity of logistics Jobs: Quantity and availability of direct and indirect jobs associated with logistics activities.

3- Rail and Seaway Cost: Overall cost to ship railcars, intermodals and containers to and from a port. Subject to the two following criteria.

   3.1- Rail Cost: Cost to ship railcars and or Intermodals from the point of origin to a transloading facility located in or around a port.

   3.2- Export Container Cost: Cost to ship a container from a port to an international client

4- Transportation Advantage: Advantage a city or state has in regards to weight limitations, timeliness and variety of trucking alternatives. Subject to the three following criteria.

   4.1- Road Weight Restrictions: Weight a port or surrounding location allows in terms of the maximum payload allowed in a container.

   4.2- Road Congestion: Overall congestion on roads of a port or a surrounding location in terms of timeliness of shipping a container from a terminal to a port.

4.3- Size of Trucking Industry: Overall trucking capacity in a given city as well as the level of competitiveness between trucking companies.

5- Economic Costs: General costs of setting-up a terminal in a specific city or state (fixed and variable). Subject to the four following criteria.

5.1- Land Cost Per Acre: Average acquisition cost of land.

5.2- Construction Cost Per Square Foot: Average residential, commercial, industrial, public, agricultural and military building construction cost.

5.3- State Tax Rate: Corporate taxation rate.

5.4- Median Wages: Average Median Wages of all occupations.

6- Local Economy: Overall performance and state of the economy in a specific city or state. Subject to the four following criteria.

6.1- Unemployment Rate: Percentage of unemployed aged 16 years old or over.

6.2- Business Climate: Cost of doing business, local economy, infrastructure, workforce, quality of life, technology and innovation, business friendliness, education, cost of living and access to capital.

6.3- Education level: Percent of achievement of a high school education or higher by state.

6.4- Local Incentives: State incentives related to overall businesses

Appendix 7 Location factors matrix

Location factors	Port attractiveness	Logistical activity	Rail and seaway cost	Transportation advantage	Economic costs	Local Economy	Priorities
Port attractiveness	1						
Logistical Activity		1					
Rail and seaway cost			1				
Transportation advantage				1			
Economic costs					1		
Local Economy						1	

Appendix 8 Location factors matrix results

Location factors	Ray-Mont upper management			
	w	r	SD	CV
Port attractiveness				
Logistical Activity				
Rail and seaway cost				
Transportation advantage				
Economic costs				
Local Economy				

Note: r denotes the rank of the location factor according to its weight w; CV = standard deviation (SD) / mean

Appendix 9 Criteria matrix

Port attractiveness

Criteria	Total TEU	Export Grain TEU	Empty container availability	Flexibility	Long term growth of business	Priorities
Total TEU	1					
Export Grain TEU		1				
Empty container availability			1			
Flexibility				1		
Long term growth of business					1	

Logistical activity

Criteria	Logistics cluster size	Free trade zone size	Quantity of logistics jobs	Priorities
Logistics cluster size	1			
Free trade zone size		1		
Quantity of logistics jobs			1	

Rail and seaway cost

Criteria	Rail cost	Export container cost	Priorities
Rail cost	1		
Export container cost		1	

Transportation advantage

Criteria	Road weight restrictions	Road congestion	Size of trucking industry	Priorities
Road weight restrictions	1			
Road congestion		1		
Size of trucking industry			1	

Economic costs

Criteria	Land cost per acre	Construction cost per square foot	State tax rate	Median wages	Priorities
Land cost per acre	1				
Construction cost per square foot		1			
State tax rate			1		
Median wages				1	

Local economy

Criteria	Unemployment rate	Business climate	Education level	Local incentives	Priorities
Unemployment rate	1				
Business climate		1			
Education level			1		
Local incentives				1	

Appendix 10 Criteria matrix results by class of respondent

Criterias	Ray-Mont upper management			
	w	r	SD	CV
Total TEU				
Export Grain TEU				
Empty container availability				
Flexibility				
Long term growth of business				
Logistics cluster size				
Free trade zone size				
Quantity of logistics jobs				
Rail cost				
Export container cost				
Road weight restrictions				
Road congestion				
Size of trucking industry				
Land cost per acre				
Construction cost per square foot				
State tax rate				
Median wages				
Unemployment rate				
Business climate				
Education level				
Local incentives				

Note: r denotes the rank of the location factor according to its weight w; CV = standard deviation (SD) / mean

Appendix 11 Criteria qualitative values for alternatives

Comparison of coastal ports to flexibility						
Flexibility	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans	Priorities
Los Angeles	1					
Seattle		1				
Hampton Roads			1			
Houston				1		
New Orleans					1	

Comparison of coastal ports to long term growth of business						
Long term growth of business	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans	Priorities
Los Angeles	1					
Seattle		1				
Hampton Roads			1			
Houston				1		
New Orleans					1	

Comparison of coastal ports to rail cost						
Rail cost	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans	Priorities
Los Angeles	1					
Seattle		1				
Hampton Roads			1			
Houston				1		
New Orleans					1	

Comparison of coastal ports to export container cost						
Export container cost	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans	Priorities
Los Angeles	1					
Seattle		1				
Hampton Roads			1			
Houston				1		
New Orleans					1	

Appendix 12 Criteria quantitative values for alternatives

Criteria quantitative values for alternatives					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Total TEU					
Export Grain TEU					
Empty container availability					
Logistics cluster size					
Free trade zone size					
Quantity of logistics jobs					
Road weight restrictions					
Road congestion					
Size of trucking industry					
Land cost per acre					
Construction cost per square foot					
State tax rate					
Median wages					
Unemployment rate					
Business climate					
Education level					
Local incentives					

Appendix 13 Final Priorities

Criteria	Priorities	Synthesis of the priorities of the alternatives				
		Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Total TEU						
Export Grain TEU						
Empty container availability						
Flexibility						
Long term growth of business						
Logistics cluster size						
Free trade zone size						
Quantity of logistics jobs						
Rail Cost						
Export container cost						
Road weight restrictions						
Road congestion						
Size of trucking industry						
Land cost per acre						
Construction cost per square foot						
State tax rate						
Median wages						
Unemployment rate						
Business climate						
Education level						
Local incentives						

Synthesis of overall priorities						

Appendix 14 Questionnaire respondent 1

Location factors matrix Results

Which objective with respect to *Location Factors* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Port attractiveness	or ● Logistical Activity		○ 1	● 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
2	○ Port attractiveness	or ● Rail and seaway cost		○ 1	○ 2 ○ 3 ● 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	● Port attractiveness	or ○ Transportation advantage		○ 1	○ 2 ○ 3 ● 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	● Port attractiveness	or ○ Economic costs		○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ● 8 ○ 9
5	● Port attractiveness	or ○ Local Economy		○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ● 9
6	○ Logistical Activity	or ● Rail and seaway cost		○ 1	○ 2 ● 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	● Logistical Activity	or ○ Transportation advantage		○ 1	○ 2 ○ 3 ○ 4 ○ 5 ● 6 ○ 7 ○ 8 ○ 9
8	● Logistical Activity	or ○ Economic costs		○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ● 8 ○ 9
9	● Logistical Activity	or ○ Local Economy		○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ● 9
10	● Rail and seaway cost	or ○ Transportation advantage		○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ● 9

11	Rail and seaway cost	or Economic costs	1	2 **3** 4 **5** 6 **7** 8 **9**
12	Rail and seaway cost	or Local Economy	1	2 **3** 4 **5** 6 **7** 8 **9**
13	Transportation advantage	or Economic costs	1	2 **3** 4 **5** 6 **7** 8 **9**
14	Transportation advantage	or Local Economy	1	2 **3** 4 **5** 6 **7** 8 **9**
15	Economic costs	or Local Economy	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 8.5% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Port attractiveness	17.4%	3
2	Logistical Activity	24.6%	2
3	Rail and seaway cost	45.8%	1
4	Transportation advantage	6.9%	4
5	Economic costs	3.1%	5
6	Local Economy	2.2%	6

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5	6
1	1	0.50	0.25	4.00	8.00	9.00
2	2.00	1	0.33	6.00	8.00	9.00
3	4.00	3.00	1	9.00	9.00	9.00
4	0.25	0.17	0.11	1	3.00	7.00
5	0.12	0.12	0.11	0.33	1	2.00
6	0.11	0.11	0.11	0.14	0.50	1

Number of comparisons = 15
Consistency Ratio CR = 8.5%
Principal eigen value = 6.534
Eigenvector solution: 6 iterations, delta = 4.0E-8

Criteria matrix Results

1-Port attractiveness

Which criterion with respect to *Port attractiveness* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	○ Total TEU	or ◉ Export Grain TEU	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ◉ 7 ○ 8 ○ 9
2	○ Total TEU	or ◉ Empty container availability	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	◉ Total TEU	or ○ Flexibility	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	○ Total TEU	or ◉ Long term growth of business	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Export Grain TEU	or ○ Empty container availability	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	◉ Export Grain TEU	or ○ Flexibility	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ◉ 8 ○ 9
7	◉ Export Grain TEU	or ○ Long term growth of business	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	◉ Empty container availability	or ○ Flexibility	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ◉ 6 ○ 7 ○ 8 ○ 9
9	◉ Empty container availability	or ○ Long term growth of business	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
10	○ Flexibility	or ◉ Long term growth	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

		of business		

CR = 9.5% OK

Calculate Result | AHP | Balanced scale | Download_(.csv) | dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Total TEU	6.1%	4
2	Export Grain TEU	52.0%	1
3	Empty container availability	20.8%	2
4	Flexibility	3.4%	5
5	Long term growth of business	17.6%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.14	0.25	3.00	0.25
2	7.00	1	6.00	8.00	2.00
3	4.00	0.17	1	7.00	2.00
4	0.33	0.12	0.14	1	0.20
5	4.00	0.50	0.50	5.00	1

Number of comparisons = 10
Consistency Ratio CR = 9.5%
Principal eigen value = 5.429
Eigenvector solution: 6 iterations, delta = 6.9E-9

2-Logistical activity

Which criterion with respect to *Logistical activity* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Logistics cluster size	or Free trade zone size	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Logistics cluster size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Free trade zone size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 5.6% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Logistics cluster size	70.9%	1
2	Free trade zone size	17.9%	2
3	Quantity of logistics jobs	11.3%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	5.00	5.00
2	0.20	1	2.00
3	0.20	0.50	1

Number of comparisons = 3
Consistency Ratio CR = 5.6%
Principal eigen value = 3.054
Eigenvector solution: 4 iterations, delta = 1.0E-8

3-Rail and seaway cost

Which criterion with respect to *Rail and seaway cost* is more important, and how much more on a scale 1 to 9?

A - Importance - or B?				Equal	How much more?
1	Rail cost	or	Export container cost	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 0% OK

Calculate Result | AHP | Balanced scale | Download_(.csv) | dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Rail cost	75.0%	1
2	Export container cost	25.0%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2
1	1	3.00
2	0.33	1

Number of comparisons = 1
Consistency Ratio CR = 0.0%
Principal eigen value = 2.000
Eigenvector solution: 1 iterations, delta = 0.0E+0

4-Transportation advantage

Which criterion with respect to *Transportation advantage* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	(•) Road weight restrictions	or ( ) Road congestion	( ) 1	( ) 2 ( ) 3 ( ) 4 (•) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9
2	(•) Road weight restrictions	or ( ) Size of trucking industry	( ) 1	( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 (•) 7 ( ) 8 ( ) 9
3	(•) Road congestion	or ( ) Size of trucking industry	( ) 1	(•) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9

CR = 1.9% OK

Calculate Result (•) AHP ( ) Balanced scale Download_(.csv) [ ] dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Road weight restrictions	76.9%	1
2	Road congestion	14.7%	2
3	Size of trucking industry	8.4%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	6.00	8.00
2	0.17	1	2.00
3	0.12	0.50	1

Number of comparisons = 3
Consistency Ratio CR = 1.9%
Principal eigen value = 3.018
Eigenvector solution: 3 iterations, delta = 1.4E-8

5-Economic Costs

Which criterion with respect to *Economic costs* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Land cost per acre	or	◉ Construction cost per square foot	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
2	◉ Land cost per acre	or	○ State tax rate	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	◉ Land cost per acre	or	○ Median wages	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉ Construction cost per square foot	or	○ State tax rate	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Construction cost per square foot	or	○ Median wages	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	○ State tax rate	or	◉ Median wages	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 9.2% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Land cost per acre	31.0%	2
2	Construction cost per square foot	54.1%	1
3	State tax rate	6.5%	4
4	Median wages	8.4%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	0.33	5.00	6.00
2	3.00	1	5.00	6.00
3	0.20	0.20	1	0.50
4	0.17	0.17	2.00	1

Number of comparisons = 6
Consistency Ratio CR = 9.2%
Principal eigen value = 4.252
Eigenvector solution: 6 iterations, delta = 3.9E-9

6-Local Economy

Which criterion with respect to *Local economy* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Unemployment rate	or Business climate	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Unemployment rate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Unemployment rate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Business climate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Business climate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Education level	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 7.9% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Unemployment rate	16.8%	3
2	Business climate	23.6%	2
3	Education level	13.5%	4
4	State incentives	46.1%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	0.50	2.00	0.33
2	2.00	1	2.00	0.33
3	0.50	0.50	1	0.50
4	3.00	3.00	2.00	1

Number of comparisons = 6
Consistency Ratio CR = 7.9%
Principal eigen value = 4.215
Eigenvector solution: 5 iterations, delta = 7.7E-8

Alternative Matrix Results

1-Flexibility

Which criterion with respect to *Flexibility* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 7.5% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	38.1%	1
2	Seattle	20.1%	3
3	Norfolk	8.3%	5
4	Houston	20.5%	2
5	New Orleans	13.0%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	3.00	3.00	2.00	3.00
2	0.33	1	3.00	0.50	3.00
3	0.33	0.33	1	0.50	0.50
4	0.50	2.00	2.00	1	1.00
5	0.33	0.33	2.00	1.00	1

Number of comparisons = 10
Consistency Ratio CR = 7.5%
Principal eigen value = 5.338
Eigenvector solution: 6 iterations, delta = 4.3E-9

2-Long term growth of business

Which criterion with respect to *Long term growth of business* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 4.5% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	27.9%	2
2	Seattle	39.7%	1
3	Norfolk	10.6%	4
4	Houston	14.3%	3
5	New Orleans	7.4%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.50	3.00	2.00	5.00
2	2.00	1	3.00	4.00	3.00
3	0.33	0.33	1	0.50	2.00
4	0.50	0.25	2.00	1	2.00
5	0.20	0.33	0.50	0.50	1

Number of comparisons = 10
Consistency Ratio CR = 4.5%
Principal eigen value = 5.204
Eigenvector solution: 5 iterations, delta = 5.9E-8

3-Rail cost

Which criterion with respect to *Rail cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
2	◉ Los Angeles	or	○ Norfolk	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
3	○ Los Angeles	or	◉ Houston	○ 1	○ 2 ◉ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
4	○ Los Angeles	or	◉ New Orleans	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
5	◉ Seattle	or	○ Norfolk	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
6	◉ Seattle	or	○ Houston	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
7	◉ Seattle	or	○ New Orleans	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
8	○ Norfolk	or	◉ Houston	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
9	◉ Norfolk	or	○ New Orleans	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
10	◉ Houston	or	○ New Orleans	○ 1	○ 2 ◉ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**

CR = 9.7% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	10.3%	4
2	Seattle	47.4%	1
3	Norfolk	10.8%	3
4	Houston	21.4%	2
5	New Orleans	10.1%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.25	2.00	0.33	0.50
2	4.00	1	4.00	4.00	4.00
3	0.50	0.25	1	0.50	2.00
4	3.00	0.25	2.00	1	3.00
5	2.00	0.25	0.50	0.33	1

Number of comparisons = 10
Consistency Ratio CR = 9.7%
Principal eigen value = 5.436
Eigenvector solution: 4 iterations, delta = 4.3E-8

4-Export container cost

Which criterion with respect to *Export container cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.3% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	14.3%	3
2	Seattle	52.4%	1
3	Norfolk	6.5%	5
4	Houston	18.7%	2
5	New Orleans	8.1%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.25	3.00	0.33	3.00
2	4.00	1	5.00	5.00	6.00
3	0.33	0.20	1	0.50	0.50
4	3.00	0.20	2.00	1	2.00
5	0.33	0.17	2.00	0.50	1

Number of comparisons = 10
Consistency Ratio CR = 9.3%
Principal eigen value = 5.417
Eigenvector solution: 6 iterations, delta = 1.4E-8

Appendix 15 Questionnaire respondent 2

Location factors matrix Results

Which objective with respect to *Location factors* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	◉ Port attractiveness	or ○	Logistical Activity	○ 1	○ 2 ○ **3** ○ 4 ◉ **5** ○ 6 ○ **7** ○ 8 ○ **9**
2	◉ Port attractiveness	or ○	Rail and seaway cost	◉ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
3	◉ Port attractiveness	or ○	Transportation advantage	◉ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
4	◉ Port attractiveness	or ○	Economic costs	◉ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
5	◉ Port attractiveness	or ○	Local Economy	○ 1	○ 2 ○ **3** ○ 4 ◉ **5** ○ 6 ○ **7** ○ 8 ○ **9**
6	○ Logistical Activity	or ◉	Rail and seaway cost	○ 1	○ 2 ○ **3** ◉ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
7	○ Logistical Activity	or ◉	Transportation advantage	○ 1	○ 2 ◉ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
8	○ Logistical Activity	or ◉	Economic costs	○ 1	○ 2 ○ **3** ○ 4 ◉ **5** ○ 6 ○ **7** ○ 8 ○ **9**
9	◉ Logistical Activity	or ○	Local Economy	◉ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
10	○ Rail and seaway	or ◉	Transportation	○ 1	○ 2 ◉ **3** ○ 4 ○ **5** ○ 6 ○ **7**

	cost	advantage		8 9
11	Rail and seaway cost	or Economic costs	1	2 3 4 5 6 7 8 9
12	Rail and seaway cost	or Local Economy	1	2 3 4 5 6 7 8 9
13	Transportation advantage	or Economic costs	1	2 3 4 5 6 7 8 9
14	Transportation advantage	or Local Economy	1	2 3 4 5 6 7 8 9
15	Economic costs	or Local Economy	1	2 3 4 5 6 7 8 9

CR = 6.6% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Port attractiveness	21.7%	3
2	Logistical Activity	5.0%	5
3	Rail and seaway cost	14.6%	4
4	Transportation advantage	26.2%	2
5	Economic costs	27.8%	1
6	Local Economy	4.8%	6

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5	6
1	1	5.00	1.00	1.00	1.00	5.00
2	0.20	1	0.25	0.33	0.20	1.00
3	1.00	4.00	1	0.25	0.25	5.00
4	1.00	3.00	4.00	1	1.00	4.00
5	1.00	5.00	4.00	1.00	1	4.00
6	0.20	1.00	0.20	0.25	0.25	1

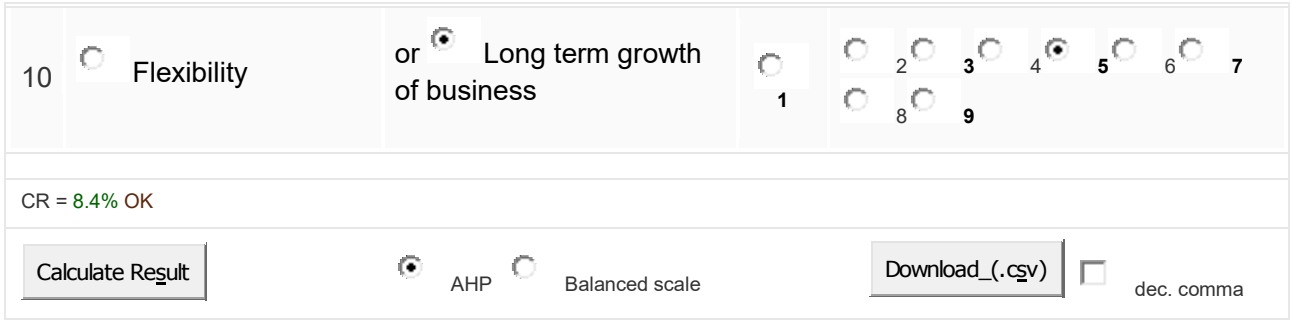
Number of comparisons = 15
Consistency Ratio CR = 6.6%
Principal eigen value = 6.411
Eigenvector solution: 6 iterations, delta = 7.0E-8

Criteria matrix Results

1-Port attractiveness

Which criterion with respect to *Port attractiveness* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Total TEU	or Export Grain TEU	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Total TEU	or Empty container availability	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Total TEU	or Flexibility	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Total TEU	or Long term growth of business	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Export Grain TEU	or Empty container availability	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Export Grain TEU	or Flexibility	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Export Grain TEU	or Long term growth of business	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Empty container availability	or Flexibility	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Empty container availability	or Long term growth of business	1	2 **3** 4 **5** 6 **7** 8 **9**



AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Total TEU	2.7%	5
2	Export Grain TEU	5.1%	4
3	Empty container availability	23.8%	2
4	Flexibility	16.9%	3
5	Long term growth of business	51.6%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.33	0.11	0.11	0.11
2	3.00	1	0.11	0.33	0.11
3	9.00	9.00	1	1.00	0.33
4	9.00	3.00	1.00	1	0.20
5	9.00	9.00	3.00	5.00	1

Number of comparisons = 10
Consistency Ratio CR = 8.4%
Principal eigen value = 5.378
Eigenvector solution: 6 iterations, delta = 1.9E-9

2-Logistical activity

Which criterion with respect to *Logistical activity* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Logistics cluster size	or Free trade zone size	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Logistics cluster size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Free trade zone size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 0.4% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Logistics cluster size	58.2%	1
2	Free trade zone size	30.9%	2
3	Quantity of logistics jobs	10.9%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	2.00	5.00
2	0.50	1	3.00
3	0.20	0.33	1

Number of comparisons = 3
Consistency Ratio CR = 0.4%
Principal eigen value = 3.004
Eigenvector solution: 3 iterations, delta = 1.4E-9

3-Rail and seaway cost

Which criterion with respect to *Rail and seaway cost* is more important, and how much more on a scale 1 to 9?

A - Importance - or B?				Equal	How much more?
1	Rail cost	or	Export container cost	1	2 3 4 5 6 7 8 9

CR = 0% OK

Calculate Result | AHP | Balanced scale | Download_(.csv) | dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Rail cost	50.0%	1
2	Export container cost	50.0%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2
1	1	1.00
2	1.00	1

Number of comparisons = 1
Consistency Ratio CR = 0.0%
Principal eigen value = 2.000
Eigenvector solution: 1 iterations, delta = 0.0E+0

4-Transportation advantage

Which criterion with respect to *Transportation advantage* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	(•) Road weight restrictions	or ( ) Road congestion	( ) 1	( ) 2 (•) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9
2	(•) Road weight restrictions	or ( ) Size of trucking industry	( ) 1	( ) 2 ( ) 3 ( ) 4 (•) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9
3	(•) Road congestion	or ( ) Size of trucking industry	( ) 1	( ) 2 (•) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9

CR = 4% OK

Calculate Result (•) AHP ( ) Balanced scale Download_(.csv) [ ] dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Road weight restrictions	63.7%	1
2	Road congestion	25.8%	2
3	Size of trucking industry	10.5%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	3.00	5.00
2	0.33	1	3.00
3	0.20	0.33	1

Number of comparisons = 3
Consistency Ratio CR = 4.0%
Principal eigen value = 3.039
Eigenvector solution: 4 iterations, delta = 3.7E-9

5-Economic Costs

Which criterion with respect to *Economic costs* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Land cost per acre	or	Construction cost per square foot	1	2 3 4 5 6 7 8 9
2	Land cost per acre	or	State tax rate	1	2 3 4 5 6 7 8 9
3	Land cost per acre	or	Median wages	1	2 3 4 5 6 7 8 9
4	Construction cost per square foot	or	State tax rate	1	2 3 4 5 6 7 8 9
5	Construction cost per square foot	or	Median wages	1	2 3 4 5 6 7 8 9
6	State tax rate	or	Median wages	1	2 3 4 5 6 7 8 9

CR = 0% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Land cost per acre	31.2%	1
2	Construction cost per square foot	31.2%	1
3	State tax rate	31.2%	1
4	Median wages	6.2%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	1.00	1.00	5.00
2	1.00	1	1.00	5.00
3	1.00	1.00	1	5.00
4	0.20	0.20	0.20	1

Number of comparisons = 6
Consistency Ratio CR = 0.0%
Principal eigen value = 4.000
Eigenvector solution: 1 iterations, delta = 0.0E+0

6-Local Economy

Which criterion with respect to *Local economy* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Unemployment rate	or Business climate	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Unemployment rate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Unemployment rate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Business climate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Business climate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Education level	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 7.9% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Unemployment rate	13.2%	3
2	Business climate	42.0%	1
3	Education level	6.0%	4
4	State incentives	38.8%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	0.20	4.00	0.25
2	5.00	1	5.00	1.00
3	0.25	0.20	1	0.20
4	4.00	1.00	5.00	1

Number of comparisons = 6
Consistency Ratio CR = 7.9%
Principal eigen value = 4.214
Eigenvector solution: 5 iterations, delta = 9.2E-8

Alternative Matrix Results

1-Flexibility

Which criterion with respect to *Flexibility* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
2	○ Los Angeles	or	◉ Norfolk	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	○ Los Angeles	or	◉ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉ Los Angeles	or	○ New Orleans	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Seattle	or	○ Norfolk	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	◉ Seattle	or	○ Houston	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	◉ Seattle	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	◉ Norfolk	or	○ Houston	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	◉ Norfolk	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
10	◉ Houston	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 6.6% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	7.3%	4
2	Seattle	36.7%	1
3	Norfolk	23.3%	3
4	Houston	27.9%	2
5	New Orleans	4.7%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.20	0.20	0.20	3.00
2	5.00	1	3.00	1.00	5.00
3	5.00	0.33	1	1.00	5.00
4	5.00	1.00	1.00	1	5.00
5	0.33	0.20	0.20	0.20	1

Number of comparisons = 10
Consistency Ratio CR = 6.6%
Principal eigen value = 5.299
Eigenvector solution: 6 iterations, delta = 3.6E-9

2-Long term growth of business

Which criterion with respect to *Long term growth of business* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.2% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	4.5%	5
2	Seattle	36.9%	1
3	Norfolk	17.8%	3
4	Houston	33.6%	2
5	New Orleans	7.1%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.20	0.20	0.20	0.33
2	5.00	1	4.00	1.00	5.00
3	5.00	0.25	1	0.33	5.00
4	5.00	1.00	3.00	1	5.00
5	3.00	0.20	0.20	0.20	1

Number of comparisons = 10
Consistency Ratio CR = 9.2%
Principal eigen value = 5.414
Eigenvector solution: 6 iterations, delta = 3.2E-8

3-Rail cost

Which criterion with respect to *Rail cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?				Equal	How much more?
1	○	Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ◉ **9**
2	○	Los Angeles	or	◉ Norfolk	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ◉ **7** ○ 8 ○ **9**
3	○	Los Angeles	or	◉ Houston	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ◉ **7** ○ 8 ○ **9**
4	○	Los Angeles	or	◉ New Orleans	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
5	◉	Seattle	or	○ Norfolk	○ 1	○ 2 ○ **3** ◉ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
6	◉	Seattle	or	○ Houston	○ 1	○ 2 ○ **3** ◉ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
7	◉	Seattle	or	○ New Orleans	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ◉ **7** ○ 8 ○ **9**
8	○	Norfolk	or	◉ Houston	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
9	◉	Norfolk	or	○ New Orleans	○ 1	○ 2 ○ **3** ◉ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
10	◉	Houston	or	○ New Orleans	○ 1	○ 2 ○ **3** ◉ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**

CR = 9.4% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	2.8%	5
2	Seattle	55.9%	1
3	Norfolk	15.7%	3
4	Houston	20.5%	2
5	New Orleans	5.1%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.11	0.12	0.12	0.33
2	9.00	1	5.00	5.00	8.00
3	8.00	0.20	1	0.50	5.00
4	8.00	0.20	2.00	1	5.00
5	3.00	0.12	0.20	0.20	1

Number of comparisons = 10
Consistency Ratio CR = 9.4%
Principal eigen value = 5.425
Eigenvector solution: 6 iterations, delta = 1.5E-8

4-Export container cost

Which criterion with respect to *Export container cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ◉ 7 ○ 8 ○ 9
2	○ Los Angeles	or	◉ Norfolk	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	○ Los Angeles	or	◉ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉ Los Angeles	or	○ New Orleans	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Seattle	or	○ Norfolk	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	◉ Seattle	or	○ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	◉ Seattle	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	◉ Norfolk	or	○ Houston	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	◉ Norfolk	or	○ New Orleans	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
10	◉ Houston	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 9.2% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	5.5%	4
2	Seattle	54.9%	1
3	Norfolk	16.3%	3
4	Houston	18.2%	2
5	New Orleans	5.2%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.12	0.20	0.20	2.00
2	8.00	1	5.00	5.00	5.00
3	5.00	0.20	1	1.00	3.00
4	5.00	0.20	1.00	1	5.00
5	0.50	0.20	0.33	0.20	1

Number of comparisons = 10
Consistency Ratio CR = 9.2%
Principal eigen value = 5.413
Eigenvector solution: 6 iterations, delta = 9.0E-9

Appendix 16 Questionnaire respondent 3

Location factors matrix Results

Which objective with respect to *Location factors* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Port attractiveness	or ◉	Logistical activity	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ◉ 8 ○ **9**
2	○ Port attractiveness	or ◉	Rail and seaway cost	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ◉ 6 ○ **7** ○ 8 ○ **9**
3	○ Port attractiveness	or ◉	Transportation advantage	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ◉ **9**
4	○ Port attractiveness	or ◉	Economic costs	○ 1	○ 2 ○ **3** ◉ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
5	◉ Port attractiveness	or ○	Local economy	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
6	○ Logistical activity	or ◉	Rail and seaway cost	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
7	○ Logistical activity	or ◉	Transportation advantage	○ 1	○ 2 ○ ◉ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
8	◉ Logistical activity	or ○	Economic costs	○ 1	◉ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7** ○ 8 ○ **9**
9	◉ Logistical activity	or ○	Local economy	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ◉ 6 ○ **7** ○ 8 ○ **9**
10	○ Rail and seaway	or ◉	Transportation	○ 1	○ 2 ○ **3** ○ 4 ○ **5** ○ 6 ○ **7**

	cost	advantage		8 9
11	Rail and seaway cost	or Economic costs	1	2 **3** 4 **5** 6 **7** 8 **9**
12	Rail and seaway cost	or Local economy	1	2 **3** 4 **5** 6 **7** 8 **9**
13	Transportation advantage	or Economic costs	1	2 **3** 4 **5** 6 **7** 8 **9**
14	Transportation advantage	or Local economy	1	2 **3** 4 **5** 6 **7** 8 **9**
15	Economic costs	or Local economy	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 8.1% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Port attractiveness	3.2%	5
2	Logistical activity	15.1%	3
3	Rail and seaway cost	19.3%	2
4	Transportation advantage	50.9%	1
5	Economic costs	9.2%	4
6	Local economy	2.4%	6

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5	6
1	1	0.12	0.17	0.11	0.20	2.00
2	8.00	1	0.50	0.25	2.00	7.00
3	6.00	2.00	1	0.20	3.00	8.00
4	9.00	4.00	5.00	1	8.00	9.00
5	5.00	0.50	0.33	0.12	1	6.00
6	0.50	0.14	0.12	0.11	0.17	1

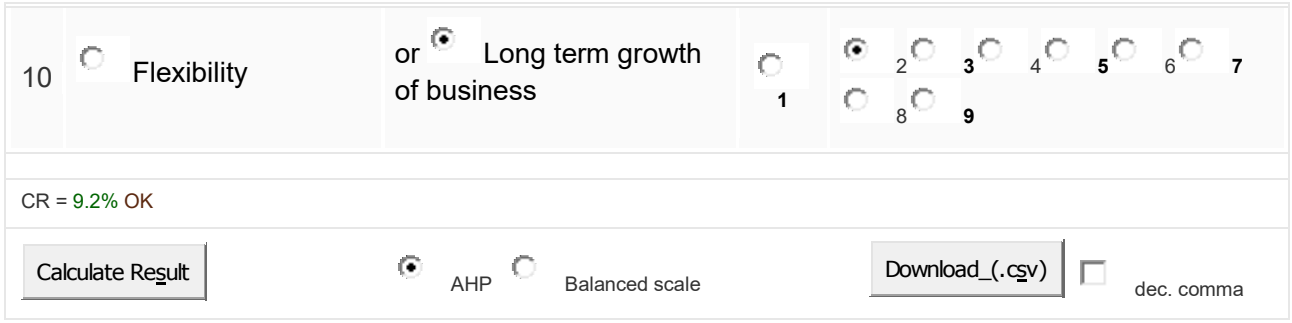
Number of comparisons = 15
Consistency Ratio CR = 8.1%
Principal eigen value = 6.509
Eigenvector solution: 6 iterations, delta = 1.1E-8

Criteria matrix Results

1-Port attractiveness

Which criterion with respect to *Port attractiveness* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Total TEU	or Export Grain TEU	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Total TEU	or Empty container availability	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Total TEU	or Flexibility	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Total TEU	or Long term growth of business	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Export Grain TEU	or Empty container availability	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Export Grain TEU	or Flexibility	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Export Grain TEU	or Long term growth of business	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Empty container availability	or Flexibility	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Empty container availability	or Long term growth of business	1	2 **3** 4 **5** 6 **7** 8 **9**



AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Total TEU	3.7%	5
2	Export Grain TEU	44.2%	1
3	Empty container availability	24.6%	2
4	Flexibility	12.7%	4
5	Long term growth of business	14.8%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.17	0.14	0.20	0.20
2	6.00	1	3.00	2.00	5.00
3	7.00	0.33	1	3.00	2.00
4	5.00	0.50	0.33	1	0.50
5	5.00	0.20	0.50	2.00	1

Number of comparisons = 10
Consistency Ratio CR = 9.2%
Principal eigen value = 5.414
Eigenvector solution: 6 iterations, delta = 2.5E-8

2-Logistical activity

Which criterion with respect to *Logistical activity* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Logistics cluster size	or Free trade zone size	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Logistics cluster size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Free trade zone size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 0% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Logistics cluster size	33.3%	1
2	Free trade zone size	33.3%	1
3	Quantity of logistics jobs	33.3%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	1.00	1.00
2	1.00	1	1.00
3	1.00	1.00	1

Number of comparisons = 3
Consistency Ratio CR = 0.0%
Principal eigen value = 3.000
Eigenvector solution: 1 iterations, delta = 0.0E+0

3-Rail and seaway cost

Which criterion with respect to *Rail and seaway cost* is more important, and how much more on a scale 1 to 9?

A - Importance - or B?				Equal	How much more?
1	Rail cost	or	Export container cost	1	2 3 4 5 6 7 8 9

CR = 0% OK

Calculate Result | AHP | Balanced scale | Download_(.csv) | dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Rail cost	87.5%	1
2	Export container cost	12.5%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2
1	1	7.00
2	0.14	1

Number of comparisons = 1
Consistency Ratio CR = 0.0%
Principal eigen value = 2.000
Eigenvector solution: 1 iterations, delta = 0.0E+0

4-Transportation advantage

Which criterion with respect to *Transportation advantage* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Road weight restrictions	or Road congestion	1	2 3 4 5 6 7 8 9
2	Road weight restrictions	or Size of trucking industry	1	2 3 4 5 6 7 8 9
3	Road congestion	or Size of trucking industry	1	2 3 4 5 6 7 8 9

CR = 0% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Road weight restrictions	80.0%	1
2	Road congestion	10.0%	2
3	Size of trucking industry	10.0%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	8.00	8.00
2	0.12	1	1.00
3	0.12	1.00	1

Number of comparisons = 3
Consistency Ratio CR = 0.0%
Principal eigen value = 3.000
Eigenvector solution: 1 iterations, delta = 0.0E+0

5-Economic Costs

Which criterion with respect to *Economic costs* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Land cost per acre	or	Construction cost per square foot	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Land cost per acre	or	State tax rate	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Land cost per acre	or	Median wages	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Construction cost per square foot	or	State tax rate	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Construction cost per square foot	or	Median wages	1	2 **3** 4 **5** 6 **7** 8 **9**
6	State tax rate	or	Median wages	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 8.6% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Land cost per acre	26.3%	2
2	Construction cost per square foot	16.3%	3
3	State tax rate	10.2%	4
4	Median wages	47.1%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	3.00	2.00	0.33
2	0.33	1	2.00	0.50
3	0.50	0.50	1	0.25
4	3.00	2.00	4.00	1

Number of comparisons = 6
Consistency Ratio CR = 8.6%
Principal eigen value = 4.235
Eigenvector solution: 5 iterations, delta = 6.6E-8

6-Local Economy

Which criterion with respect to *Local economy* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Unemployment rate	or Business climate	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Unemployment rate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Unemployment rate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Business climate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Business climate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Education level	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.6% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Unemployment rate	4.9%	4
2	Business climate	11.0%	3
3	Education level	61.7%	1
4	State incentives	22.4%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	0.25	0.14	0.20
2	4.00	1	0.14	0.33
3	7.00	7.00	1	4.00
4	5.00	3.00	0.25	1

Number of comparisons = 6
Consistency Ratio CR = 9.6%
Principal eigen value = 4.262
Eigenvector solution: 6 iterations, delta = 2.8E-9

Alternative Matrix Results

1-Flexibility

Which criterion with respect to *Flexibility* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.3% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	50.7%	1
2	Seattle	26.3%	2
3	Norfolk	6.9%	4
4	Houston	11.3%	3
5	New Orleans	4.8%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	3.00	7.00	6.00	6.00
2	0.33	1	5.00	4.00	4.00
3	0.14	0.20	1	0.33	3.00
4	0.17	0.25	3.00	1	3.00
5	0.17	0.25	0.33	0.33	1

Number of comparisons = 10
Consistency Ratio CR = 9.3%
Principal eigen value = 5.418
Eigenvector solution: 6 iterations, delta = 2.9E-8

2-Long term growth of business

Which criterion with respect to *Long term growth of business* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.5% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	48.5%	1
2	Seattle	7.0%	4
3	Norfolk	29.0%	2
4	Houston	11.1%	3
5	New Orleans	4.3%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	5.00	3.00	6.00	6.00
2	0.20	1	0.17	0.33	3.00
3	0.33	6.00	1	4.00	6.00
4	0.17	3.00	0.25	1	3.00
5	0.17	0.33	0.17	0.33	1

Number of comparisons = 10
Consistency Ratio CR = 9.5%
Principal eigen value = 5.427
Eigenvector solution: 6 iterations, delta = 4.9E-8

3-Rail cost

Which criterion with respect to *Rail cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ◉ 8 ○ 9
2	◉ Los Angeles	or	○ Norfolk	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	○ Los Angeles	or	◉ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉ Los Angeles	or	○ New Orleans	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Seattle	or	○ Norfolk	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ◉ 6 ○ 7 ○ 8 ○ 9
6	◉ Seattle	or	○ Houston	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	◉ Seattle	or	○ New Orleans	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	○ Norfolk	or	◉ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	◉ Norfolk	or	○ New Orleans	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
10	◉ Houston	or	○ New Orleans	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 8.3% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	6.5%	5
2	Seattle	53.3%	1
3	Norfolk	6.8%	4
4	Houston	22.3%	2
5	New Orleans	11.2%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.12	1.00	0.17	1.00
2	8.00	1	7.00	4.00	4.00
3	1.00	0.14	1	0.20	1.00
4	6.00	0.25	5.00	1	1.00
5	1.00	0.25	1.00	1.00	1

Number of comparisons = 10
Consistency Ratio CR = 8.3%
Principal eigen value = 5.374
Eigenvector solution: 6 iterations, delta = 7.8E-9

4-Export container cost

Which criterion with respect to *Export container cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.5% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	60.3%	1
2	Seattle	22.6%	2
3	Norfolk	9.8%	3
4	Houston	4.1%	4
5	New Orleans	3.2%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	5.00	9.00	9.00	9.00
2	0.20	1	3.00	8.00	8.00
3	0.11	0.33	1	4.00	4.00
4	0.11	0.12	0.25	1	2.00
5	0.11	0.12	0.25	0.50	1

Number of comparisons = 10
Consistency Ratio CR = 9.5%
Principal eigen value = 5.428
Eigenvector solution: 6 iterations, delta = 6.1E-9

Appendix 17 Questionnaire respondent 4

Location factors matrix Results

Which objective with respect to *Location factors* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○	Port attractiveness	or ◉ Logistical activity	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ◉ 6 ○ 7 ○ 8 ○ 9
2	◉	Port attractiveness	or ○ Rail and seaway cost	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	○	Port attractiveness	or ◉ Transportation advantage	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ◉ 7 ○ 8 ○ 9
4	○	Port attractiveness	or ◉ Economic costs	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉	Port attractiveness	or ○ Local economy	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	◉	Logistical activity	or ○ Rail and seaway cost	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	○	Logistical activity	or ◉ Transportation advantage	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	◉	Logistical activity	or ○ Economic costs	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	◉	Logistical activity	or ○ Local economy	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9

10	Rail and seaway cost	or Transportation advantage	1	2 3 4 5 6 7 8 9
11	Rail and seaway cost	or Economic costs	1	2 3 4 5 6 7 8 9
12	Rail and seaway cost	or Local economy	1	2 3 4 5 6 7 8 9
13	Transportation advantage	or Economic costs	1	2 3 4 5 6 7 8 9
14	Transportation advantage	or Local economy	1	2 3 4 5 6 7 8 9
15	Economic costs	or Local economy	1	2 3 4 5 6 7 8 9

CR = 9.7% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Port attractiveness	6.5%	4
2	Logistical activity	24.7%	2
3	Rail and seaway cost	4.4%	5
4	Transportation advantage	45.6%	1
5	Economic costs	16.0%	3
6	Local economy	2.8%	6

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5	6
1	1	0.17	3.00	0.14	0.25	3.00
2	6.00	1	5.00	0.33	3.00	5.00
3	0.33	0.20	1	0.14	0.17	3.00
4	7.00	3.00	7.00	1	5.00	9.00
5	4.00	0.33	6.00	0.20	1	7.00
6	0.33	0.20	0.33	0.11	0.14	1

Number of comparisons = 15
Consistency Ratio CR = 9.7%
Principal eigen value = 6.610
Eigenvector solution: 7 iterations, delta = 1.1E-8

Criteria matrix Results

1-Port attractiveness

Which criterion with respect to *Port attractiveness* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Total TEU	or Export Grain TEU	1	2 3 4 5 6 7 8 9
2	Total TEU	or Empty container availability	1	2 3 4 5 6 7 8 9
3	Total TEU	or Flexibility	1	2 3 4 5 6 7 8 9
4	Total TEU	or Long term growth of business	1	2 3 4 5 6 7 8 9
5	Export Grain TEU	or Empty container availability	1	2 3 4 5 6 7 8 9
6	Export Grain TEU	or Flexibility	1	2 3 4 5 6 7 8 9
7	Export Grain TEU	or Long term growth of business	1	2 3 4 5 6 7 8 9
8	Empty container availability	or Flexibility	1	2 3 4 5 6 7 8 9

9	Empty container availability	or Long term growth of business	1	2 3 4 5 6 7 8 9
10	Flexibility	or Long term growth of business	1	2 3 4 5 6 7 8 9

CR = 9.5% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Total TEU	3.6%	5
2	Export Grain TEU	49.4%	1
3	Empty container availability	17.0%	3
4	Flexibility	6.2%	4
5	Long term growth of business	23.8%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.14	0.12	0.33	0.20
2	7.00	1	5.00	6.00	3.00
3	8.00	0.20	1	4.00	0.50
4	3.00	0.17	0.25	1	0.17
5	5.00	0.33	2.00	6.00	1

Number of comparisons = 10
Consistency Ratio CR = 9.5%

Principal eigen value = 5.429
Eigenvector solution: 6 iterations, delta = 1.8E-8

2-Logistical activity

Which criterion with respect to *Logistical activity* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	(•) Logistics cluster size	or ( ) Free trade zone size	( ) 1	( ) 2 ( ) **3** ( ) 4 ( ) **5** ( ) 6 (•) **7** ( ) 8 ( ) **9**
2	(•) Logistics cluster size	or ( ) Quantity of logistics jobs	( ) 1	( ) 2 (•) **3** ( ) 4 ( ) **5** ( ) 6 ( ) **7** ( ) 8 ( ) **9**
3	( ) Free trade zone size	or (•) Quantity of logistics jobs	( ) 1	( ) 2 (•) **3** ( ) 4 ( ) **5** ( ) 6 ( ) **7** ( ) 8 ( ) **9**

CR = 5.6% OK

Calculate Result (•) AHP ( ) Balanced scale Download_(.csv) [ ] dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Logistics cluster size	70.7%	1
2	Free trade zone size	7.0%	3
3	Quantity of logistics jobs	22.3%	2

Decision Matrix

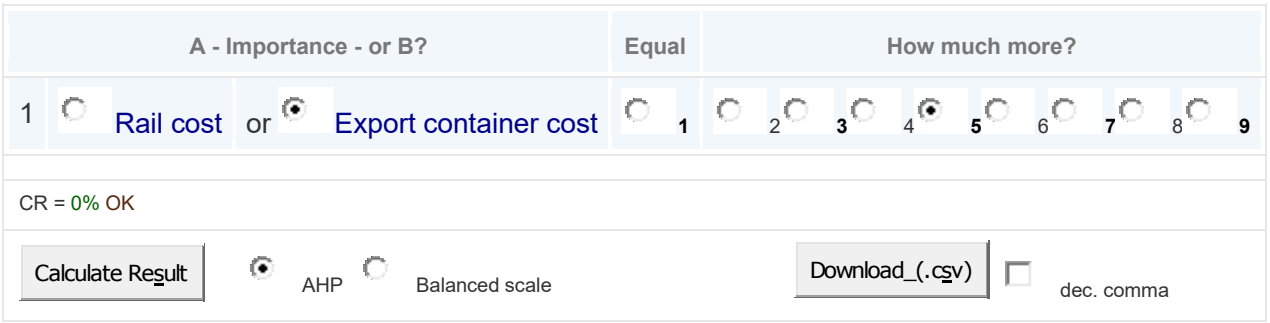
The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	8.00	4.00
2	0.12	1	0.25
3	0.25	4.00	1

Number of comparisons = 3
Consistency Ratio CR = 5.6%
Principal eigen value = 3.054
Eigenvector solution: 4 iterations, delta = 8.8E-9

3-Rail and seaway cost

Which criterion with respect to *Rail and seaway cost* is more important, and how much more on a scale 1 to 9?



AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Rail cost	16.7%	2
2	Export container cost	83.3%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2
1	1	0.20
2	5.00	1

Number of comparisons = 1
Consistency Ratio CR = 0.0%
Principal eigen value = 2.000
Eigenvector solution: 1 iterations, delta = 7.7E-34

4-Transportation advantage

Which criterion with respect to *Transportation advantage* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	(•) Road weight restrictions	or ( ) Road congestion	( ) 1	( ) 2 (•) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9
2	(•) Road weight restrictions	or ( ) Size of trucking industry	( ) 1	( ) 2 ( ) 3 ( ) 4 ( ) 5 (•) 6 ( ) 7 ( ) 8 ( ) 9
3	(•) Road congestion	or ( ) Size of trucking industry	( ) 1	( ) 2 (•) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9

CR = 8% OK

Calculate Result (•) AHP ( ) Balanced scale Download_(.csv) [ ] dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Road weight restrictions	69.6%	1
2	Road congestion	22.9%	2
3	Size of trucking industry	7.5%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	4.00	7.00
2	0.25	1	4.00
3	0.14	0.25	1

Number of comparisons = 3
Consistency Ratio CR = 8.0%
Principal eigen value = 3.076
Eigenvector solution: 4 iterations, delta = 4.2E-8

5-Economic Costs

Which criterion with respect to *Economic costs* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Land cost per acre	or	Construction cost per square foot	1	2 3 4 5 6 7 8 9
2	Land cost per acre	or	State tax rate	1	2 3 4 5 6 7 8 9
3	Land cost per acre	or	Median wages	1	2 3 4 5 6 7 8 9
4	Construction cost per square foot	or	State tax rate	1	2 3 4 5 6 7 8 9
5	Construction cost per square foot	or	Median wages	1	2 3 4 5 6 7 8 9
6	State tax rate	or	Median wages	1	2 3 4 5 6 7 8 9

CR = 8.6% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Land cost per acre	65.3%	1
2	Construction cost per square foot	10.3%	3
3	State tax rate	20.2%	2
4	Median wages	4.3%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	7.00	5.00	9.00
2	0.14	1	0.33	4.00
3	0.20	3.00	1	5.00
4	0.11	0.25	0.20	1

Number of comparisons = 6
Consistency Ratio CR = 8.6%

Principal eigen value = 4.235
Eigenvector solution: 6 iterations, delta = 1.4E-9

6-Local Economy

Which criterion with respect to *Local economy* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Unemployment rate	or Business climate	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Unemployment rate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Unemployment rate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Business climate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Business climate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Education level	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 8.7% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Unemployment rate	10.2%	3
2	Business climate	63.2%	1
3	Education level	5.2%	4
4	State incentives	21.4%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	0.17	3.00	0.33
2	6.00	1	7.00	5.00
3	0.33	0.14	1	0.20
4	3.00	0.20	5.00	1

Number of comparisons = 6
Consistency Ratio CR = 8.7%
Principal eigen value = 4.236
Eigenvector solution: 6 iterations, delta = 1.3E-9

Alternative Matrix Results

1-Flexibility

Which criterion with respect to *Flexibility* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 8.5% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	27.6%	2
2	Seattle	52.8%	1
3	Norfolk	3.1%	5
4	Houston	5.4%	4
5	New Orleans	11.2%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.33	7.00	7.00	4.00
2	3.00	1	9.00	8.00	7.00
3	0.14	0.11	1	0.33	0.17
4	0.14	0.12	3.00	1	0.33
5	0.25	0.14	6.00	3.00	1

Number of comparisons = 10
Consistency Ratio CR = 8.5%
Principal eigen value = 5.385
Eigenvector solution: 6 iterations, delta = 1.9E-8

2-Long term growth of business

Which criterion with respect to *Long term growth of business* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Los Angeles	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Los Angeles	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Seattle	or	Norfolk	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Seattle	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
7	Seattle	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
8	Norfolk	or	Houston	1	2 **3** 4 **5** 6 **7** 8 **9**
9	Norfolk	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**
10	Houston	or	New Orleans	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.4% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	6.2%	4
2	Seattle	54.2%	1
3	Norfolk	3.5%	5
4	Houston	13.3%	3
5	New Orleans	22.9%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.17	3.00	0.25	0.20
2	6.00	1	9.00	6.00	4.00
3	0.33	0.11	1	0.20	0.20
4	4.00	0.17	5.00	1	0.33
5	5.00	0.25	5.00	3.00	1

Number of comparisons = 10
Consistency Ratio CR = 9.4%
Principal eigen value = 5.424
Eigenvector solution: 6 iterations, delta = 3.7E-8

3-Rail cost

Which criterion with respect to *Rail cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?				Equal	How much more?
1	○	Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ◉ 7 ○ 8 ○ 9
2	◉	Los Angeles	or	○ Norfolk	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	○	Los Angeles	or	◉ Houston	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉	Los Angeles	or	○ New Orleans	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉	Seattle	or	○ Norfolk	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ◉ 9
6	◉	Seattle	or	○ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	◉	Seattle	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ◉ 7 ○ 8 ○ 9
8	○	Norfolk	or	◉ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	○	Norfolk	or	◉ New Orleans	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
10	◉	Houston	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 9.6% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	11.7%	3
2	Seattle	60.6%	1
3	Norfolk	3.5%	5
4	Houston	19.5%	2
5	New Orleans	4.8%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.14	5.00	0.33	4.00
2	7.00	1	9.00	6.00	8.00
3	0.20	0.11	1	0.20	0.50
4	3.00	0.17	5.00	1	5.00
5	0.25	0.12	2.00	0.20	1

Number of comparisons = 10
Consistency Ratio CR = 9.6%
Principal eigen value = 5.433
Eigenvector solution: 6 iterations, delta = 1.8E-8

4-Export container cost

Which criterion with respect to *Export container cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Los Angeles	or	Norfolk	1	2 3 4 5 6 7 8 **9**
3	Los Angeles	or	Houston	1	2 3 4 **5** 6 7 8 9
4	Los Angeles	or	New Orleans	1	2 3 4 5 6 7 8 **9**
5	Seattle	or	Norfolk	1	2 3 4 5 6 7 8 **9**
6	Seattle	or	Houston	1	2 3 4 5 6 **7** 8 9
7	Seattle	or	New Orleans	1	2 3 4 5 6 **7** 8 9
8	Norfolk	or	Houston	1	2 **3** 4 5 6 7 8 9
9	Norfolk	or	New Orleans	1	**2** 3 4 5 6 7 8 9
10	Houston	or	New Orleans	1	**2** 3 4 5 6 7 8 9

CR = 8.7% OK

Calculate Result | AHP | Balanced scale | Download_(.csv) | dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	29.3%	2
2	Seattle	55.4%	1
3	Norfolk	3.1%	5
4	Houston	7.6%	3
5	New Orleans	4.6%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.25	9.00	6.00	9.00
2	4.00	1	9.00	8.00	8.00
3	0.11	0.11	1	0.25	0.50
4	0.17	0.12	4.00	1	2.00
5	0.11	0.12	2.00	0.50	1

Number of comparisons = 10
Consistency Ratio CR = 8.7%
Principal eigen value = 5.389
Eigenvector solution: 6 iterations, delta = 1.5E-8

Appendix 18 Questionnaire respondent 5

Location factors matrix Results

Which criterion with respect to *Location factors* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Port attractiveness	or ◉	Logistical activity	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
2	○ Port attractiveness	or ◉	Rail and seaway cost	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ◉ 9
3	○ Port attractiveness	or ◉	Transportation advantage	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ◉ 8 ○ 9
4	◉ Port attractiveness	or ○	Economic costs	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Port attractiveness	or ○	Local economy	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	○ Logistical activity	or ◉	Rail and seaway cost	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	○ Logistical activity	or ◉	Transportation advantage	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	◉ Logistical activity	or ○	Economic costs	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	◉ Logistical activity	or ○	Local economy	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

10	Rail and seaway cost	or Transportation advantage	1	2 **3** 4 **5** 6 **7** 8 **9**
11	Rail and seaway cost	or Economic costs	1	2 **3** 4 **5** 6 **7** 8 **9**
12	Rail and seaway cost	or Local economy	1	2 **3** 4 **5** 6 **7** 8 **9**
13	Transportation advantage	or Economic costs	1	2 **3** 4 **5** 6 **7** 8 **9**
14	Transportation advantage	or Local economy	1	2 **3** 4 **5** 6 **7** 8 **9**
15	Economic costs	or Local economy	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 9.3% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Port attractiveness	5.4%	5
2	Logistical activity	12.3%	3
3	Rail and seaway cost	47.2%	1
4	Transportation advantage	26.3%	2
5	Economic costs	5.5%	4
6	Local economy	3.2%	6

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5	6
1	1	0.25	0.11	0.12	1.00	4.00
2	4.00	1	0.33	0.50	1.00	4.00
3	9.00	3.00	1	4.00	8.00	9.00
4	8.00	2.00	0.25	1	7.00	9.00
5	1.00	1.00	0.12	0.14	1	1.00
6	0.25	0.25	0.11	0.11	1.00	1

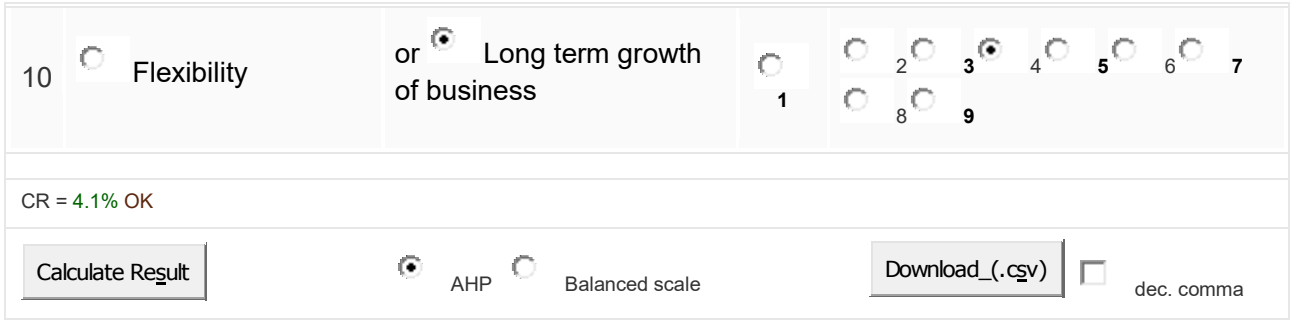
Number of comparisons = 15
Consistency Ratio CR = 9.3%
Principal eigen value = 6.585
Eigenvector solution: 6 iterations, delta = 2.2E-9

Criteria matrix Results

1-Port attractiveness

Which criterion with respect to *Port attractiveness* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○	Total TEU	or ◉ Export Grain TEU	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ◉ 9
2	○	Total TEU	or ◉ Empty container availability	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ◉ 8 ○ 9
3	◉	Total TEU	or ○ Flexibility	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉	Total TEU	or ○ Long term growth of business	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉	Export Grain TEU	or ○ Empty container availability	◉ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	◉	Export Grain TEU	or ○ Flexibility	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ◉ 8 ○ 9
7	◉	Export Grain TEU	or ○ Long term growth of business	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	◉	Empty container availability	or ○ Flexibility	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ◉ 8 ○ 9
9	◉	Empty container availability	or ○ Long term growth of business	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9



AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Total TEU	5.4%	4
2	Export Grain TEU	42.1%	1
3	Empty container availability	39.3%	2
4	Flexibility	4.3%	5
5	Long term growth of business	8.9%	3

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.11	0.12	1.00	1.00
2	9.00	1	1.00	8.00	6.00
3	8.00	1.00	1	8.00	5.00
4	1.00	0.12	0.12	1	0.25
5	1.00	0.17	0.20	4.00	1

Number of comparisons = 10
Consistency Ratio CR = 4.1%
Principal eigen value = 5.184
Eigenvector solution: 4 iterations, delta = 6.0E-8

2-Logistical activity

Which criterion with respect to *Logistical activity* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Logistics cluster size	or Free trade zone size	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Logistics cluster size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Free trade zone size	or Quantity of logistics jobs	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 1% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Logistics cluster size	45.8%	1
2	Free trade zone size	41.6%	2
3	Quantity of logistics jobs	12.6%	3

Decision Matrix

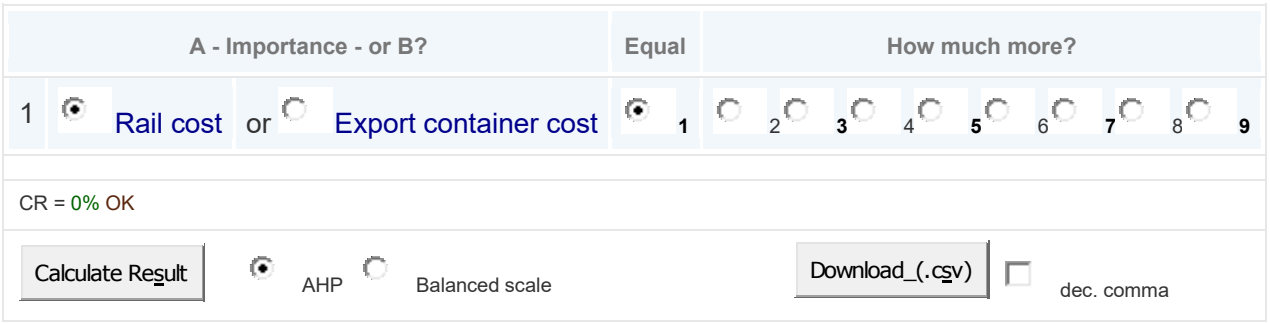
The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	1.00	4.00
2	1.00	1	3.00
3	0.25	0.33	1

Number of comparisons = 3
Consistency Ratio CR = 1.0%
Principal eigen value = 3.009
Eigenvector solution: 3 iterations, delta = 5.9E-8

3-Rail and seaway cost

Which criterion with respect to *Rail and seaway cost* is more important, and how much more on a scale 1 to 9?



AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Rail cost	50.0%	1
2	Export container cost	50.0%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2
1	1	1.00
2	1.00	1

Number of comparisons = 1
Consistency Ratio CR = 0.0%
Principal eigen value = 2.000
Eigenvector solution: 1 iterations, delta = 0.0E+0

4-Transportation advantage

Which criterion with respect to *Transportation advantage* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	(•) Road weight restrictions	or ( ) Road congestion	( ) 1	( ) 2 ( ) 3 ( ) 4 (•) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9
2	(•) Road weight restrictions	or ( ) Size of trucking industry	( ) 1	( ) 2 ( ) 3 (•) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9
3	( ) Road congestion	or (•) Size of trucking industry	( ) 1	( ) 2 (•) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9

CR = 9.8% OK

Calculate Result (•) AHP ( ) Balanced scale Download_(.csv) [ ] dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Road weight restrictions	71.7%	1
2	Road congestion	8.8%	3
3	Size of trucking industry	19.5%	2

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	6.00	5.00
2	0.17	1	0.33
3	0.20	3.00	1

Number of comparisons = 3
Consistency Ratio CR = 9.8%

Principal eigen value = 3.094
Eigenvector solution: 4 iterations, delta = 9.3E-8

5-Economic Costs

Which criterion with respect to *Economic costs* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	◉ Land cost per acre	or ○ Construction cost per square foot		○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
2	◉ Land cost per acre	or ○ State tax rate		○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	◉ Land cost per acre	or ○ Median wages		○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	○ Construction cost per square foot	or ◉ State tax rate		○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Construction cost per square foot	or ○ Median wages		○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	◉ State tax rate	or ○ Median wages		○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 9.1% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Land cost per acre	55.0%	1
2	Construction cost per square foot	13.5%	3
3	State tax rate	23.2%	2
4	Median wages	8.3%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	5.00	3.00	5.00
2	0.20	1	0.33	3.00
3	0.33	3.00	1	2.00
4	0.20	0.33	0.50	1

Number of comparisons = 6
Consistency Ratio CR = 9.1%
Principal eigen value = 4.249
Eigenvector solution: 5 iterations, delta = 8.1E-8

6-Local Economy

Which criterion with respect to *Local economy* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?		Equal	How much more?
1	Unemployment rate	or Business climate	1	2 **3** 4 **5** 6 **7** 8 **9**
2	Unemployment rate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
3	Unemployment rate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
4	Business climate	or Education level	1	2 **3** 4 **5** 6 **7** 8 **9**
5	Business climate	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**
6	Education level	or State incentives	1	2 **3** 4 **5** 6 **7** 8 **9**

CR = 4.3% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Unemployment rate	18.3%	3
2	Business climate	28.3%	2
3	Education level	16.3%	4
4	State incentives	37.1%	1

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4
1	1	1.00	1.00	0.33
2	1.00	1	2.00	1.00
3	1.00	0.50	1	0.50
4	3.00	1.00	2.00	1

Number of comparisons = 6
Consistency Ratio CR = 4.3%
Principal eigen value = 4.118
Eigenvector solution: 4 iterations, delta = 1.5E-8

Alternative Matrix Results

1-Flexibility

Which criterion with respect to *Flexibility* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	5
2	Los Angeles	or	Norfolk	1	2
3	Los Angeles	or	Houston	1	4
4	Los Angeles	or	New Orleans	1	4
5	Seattle	or	Norfolk	1	2
6	Seattle	or	Houston	1	2
7	Seattle	or	New Orleans	1	2
8	Norfolk	or	Houston	1	3
9	Norfolk	or	New Orleans	1	3
10	Houston	or	New Orleans	1	2

CR = 5.4% OK

Calculate Result | AHP | Balanced scale | Download_(.csv) | dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	50.5%	1
2	Seattle	12.1%	3
3	Norfolk	22.8%	2
4	Houston	8.5%	4
5	New Orleans	6.1%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	6.00	3.00	5.00	5.00
2	0.17	1	0.33	2.00	3.00
3	0.33	3.00	1	3.00	3.00
4	0.20	0.50	0.33	1	2.00
5	0.20	0.33	0.33	0.50	1

Number of comparisons = 10
Consistency Ratio CR = 5.4%
Principal eigen value = 5.244
Eigenvector solution: 5 iterations, delta = 5.0E-8

2-Long term growth of business

Which criterion with respect to *Long term growth of business* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	Los Angeles	or	Seattle	1	2 3 4 5 6 7 8 9
2	Los Angeles	or	Norfolk	1	2 3 4 5 6 7 8 9
3	Los Angeles	or	Houston	1	2 3 4 5 6 7 8 9
4	Los Angeles	or	New Orleans	1	2 3 4 5 6 7 8 9
5	Seattle	or	Norfolk	1	2 3 4 5 6 7 8 9
6	Seattle	or	Houston	1	2 3 4 5 6 7 8 9
7	Seattle	or	New Orleans	1	2 3 4 5 6 7 8 9
8	Norfolk	or	Houston	1	2 3 4 5 6 7 8 9
9	Norfolk	or	New Orleans	1	2 3 4 5 6 7 8 9
10	Houston	or	New Orleans	1	2 3 4 5 6 7 8 9

CR = 9.3% OK

Calculate Result AHP Balanced scale Download_(.csv) dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	33.3%	1
2	Seattle	30.1%	2
3	Norfolk	14.5%	4
4	Houston	15.7%	3
5	New Orleans	6.4%	5

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	2.00	1.00	3.00	4.00
2	0.50	1	3.00	3.00	4.00
3	1.00	0.33	1	0.50	2.00
4	0.33	0.33	2.00	1	3.00
5	0.25	0.25	0.50	0.33	1

Number of comparisons = 10
Consistency Ratio CR = 9.3%
Principal eigen value = 5.419
Eigenvector solution: 6 iterations, delta = 5.9E-8

3-Rail cost

Which criterion with respect to *Rail cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
2	◉ Los Angeles	or	○ Norfolk	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	○ Los Angeles	or	◉ Houston	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉ Los Angeles	or	○ New Orleans	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Seattle	or	○ Norfolk	○ 1	○ 2 ○ 3 ○ 4 ○ 5 ◉ 6 ○ 7 ○ 8 ○ 9
6	◉ Seattle	or	○ Houston	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	◉ Seattle	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	○ Norfolk	or	◉ Houston	○ 1	○ 2 ○ 3 ○ 4 ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	○ Norfolk	or	◉ New Orleans	○ 1	○ 2 ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
10	◉ Houston	or	○ New Orleans	○ 1	○ 2 ○ 3 ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 9.3% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	13.1%	3
2	Seattle	52.9%	1
3	Norfolk	3.9%	5
4	Houston	22.9%	2
5	New Orleans	7.3%	4

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.17	5.00	0.33	3.00
2	6.00	1	7.00	4.00	5.00
3	0.20	0.14	1	0.20	0.33
4	3.00	0.25	5.00	1	4.00
5	0.33	0.20	3.00	0.25	1

Number of comparisons = 10
Consistency Ratio CR = 9.3%
Principal eigen value = 5.420
Eigenvector solution: 6 iterations, delta = 2.3E-8

4-Export container cost

Which criterion with respect to *Export container cost* is more important, and how much more on a scale 1 to 9?

	A - Importance - or B?			Equal	How much more?
1	○ Los Angeles	or	◉ Seattle	○ 1	○ 2 ○ ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
2	◉ Los Angeles	or	○ Norfolk	○ 1	○ 2 ○ 3 ○ ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
3	◉ Los Angeles	or	○ Houston	○ 1	○ 2 ○ ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
4	◉ Los Angeles	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ ◉ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
5	◉ Seattle	or	○ Norfolk	○ 1	○ 2 ○ 3 ○ 4 ○ ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
6	◉ Seattle	or	○ Houston	○ 1	○ 2 ○ ◉ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
7	◉ Seattle	or	○ New Orleans	○ 1	○ 2 ○ 3 ○ 4 ○ ◉ 5 ○ 6 ○ 7 ○ 8 ○ 9
8	◉ Norfolk	or	○ Houston	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
9	◉ Norfolk	or	○ New Orleans	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9
10	◉ Houston	or	○ New Orleans	○ 1	◉ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

CR = 7.9% OK

Calculate Result ◉ AHP ○ Balanced scale Download_(.csv) ☐ dec. comma

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Los Angeles	26.6%	2
2	Seattle	51.3%	1
3	Norfolk	9.2%	3
4	Houston	7.9%	4
5	New Orleans	5.1%	5

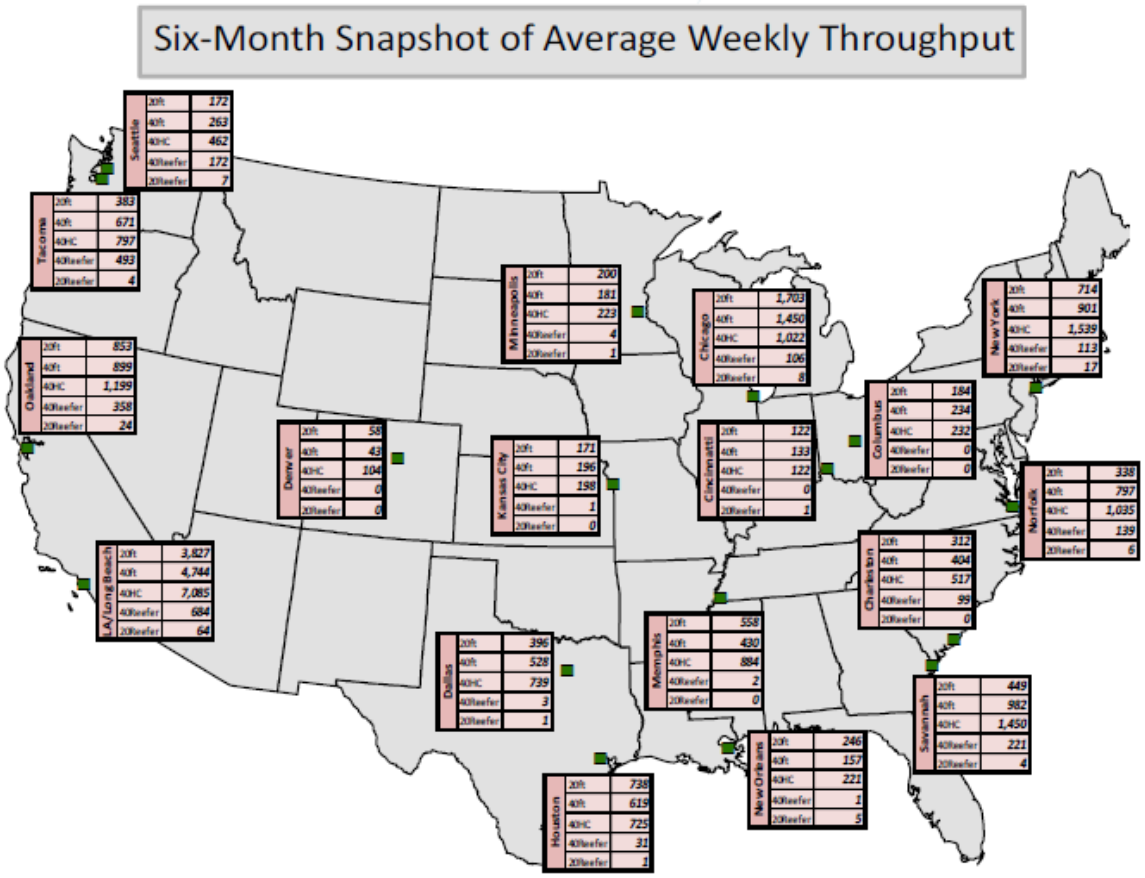
Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	0.25	5.00	4.00	5.00
2	4.00	1	6.00	4.00	6.00
3	0.20	0.17	1	2.00	2.00
4	0.25	0.25	0.50	1	2.00
5	0.20	0.17	0.50	0.50	1

Number of comparisons = 10
Consistency Ratio CR = 7.9%
Principal eigen value = 5.357
Eigenvector solution: 6 iterations, delta = 6.1E-9

Appendix 19 Six-Month Snapshot of empty container availability



Appendix 20 Location factor results

Location Factors	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Portuary attractiveness	17.40%	21.70%	3.20%	6.50%	5.40%	10.84%	5	7.3%	68%
Logistical Activity	24.60%	5.00%	15.10%	24.70%	12.30%	16.34%	3	7.5%	46%
Rail and seaway cost	45.80%	14.60%	19.30%	4.40%	47.20%	26.26%	2	17.2%	66%
Transportation advantage	6.90%	26.20%	50.90%	45.60%	26.30%	31.18%	1	15.7%	50%
Economic costs	3.10%	27.80%	9.20%	16.00%	5.50%	12.32%	4	8.9%	72%
Local Economy	2.20%	4.80%	2.40%	2.80%	3.20%	3.08%	6	0.9%	30%

Appendix 21 Criterion results

Port attractiveness criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Total TEU	6.10%	2.70%	3.70%	3.60%	5.40%	4.30%	5	1.3%	29%
Export Grain TEU	52.00%	5.10%	44.20%	49.40%	42.10%	38.56%	1	17.1%	44%
Empty container availability	20.80%	23.80%	24.60%	17.00%	39.30%	25.10%	2	7.6%	30%
Flexibility	3.40%	16.90%	12.70%	6.20%	4.30%	8.70%	4	5.2%	60%
Long term growth of business	17.60%	51.60%	14.80%	23.80%	8.90%	23.34%	3	14.9%	64%

Logistical activity criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Logistics cluster size	70.90%	58.20%	33.33%	70.70%	45.80%	55.79%	1	14.6%	26%
Free trade zone size	17.90%	30.90%	33.33%	8.00%	41.60%	26.35%	2	11.9%	45%
Quantity of logistics jobs	11.30%	10.90%	33.33%	22.30%	12.60%	18.09%	3	8.7%	48%

Rail and seaway cost criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Rail cost	75.00%	50.00%	87.50%	16.70%	50.00%	55.84%	1	24.4%	44%
Export container cost	25.00%	50.00%	12.50%	83.30%	50.00%	44.16%	2	24.4%	55%

Transportation advantage criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Road weight restrictions	76.90%	63.70%	80.00%	69.60%	71.70%	72.38%	1	5.7%	8%
Road congestion	14.70%	25.80%	10.00%	22.90%	8.80%	16.44%	2	6.8%	41%
Size of trucking industry	8.40%	10.50%	10.00%	7.50%	19.50%	11.18%	3	4.3%	38%

Economic costs criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Land cost per acre	31.00%	31.20%	26.30%	65.30%	55.00%	41.76%	1	15.5%	37%
Construction cost per square foot	54.10%	31.20%	16.30%	10.30%	13.50%	25.08%	2	16.2%	65%
State tax rate	6.50%	31.20%	10.20%	20.20%	23.20%	18.26%	3	8.9%	49%
Median wages	8.40%	6.20%	47.10%	4.30%	8.30%	14.86%	4	16.2%	109%

Local economy criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Unemployment rate	16.80%	13.20%	4.90%	10.20%	18.30%	12.68%	4	4.8%	38%
Business climate	23.60%	42.00%	11.00%	63.20%	28.30%	33.62%	1	17.8%	53%
Education level	13.50%	6.00%	61.70%	5.20%	16.30%	20.54%	3	21.0%	102%
State incentives	46.10%	38.80%	22.40%	21.40%	37.10%	33.16%	2	9.7%	29%

Appendix 22 Alternative results

Flexibility	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	38.10%	7.30%	50.70%	27.60%	50.50%	34.84%	1	16.2%	47%
Seattle	20.10%	36.70%	26.30%	52.80%	12.10%	29.60%	2	14.1%	48%
Norfolk	8.30%	23.30%	6.90%	3.10%	22.80%	12.88%	4	8.5%	66%
Houston	20.50%	27.90%	11.30%	5.40%	8.50%	14.72%	3	8.3%	56%
New Orleans	13.00%	4.70%	4.80%	11.20%	6.10%	7.96%	5	3.5%	44%

Long term growth of business	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	27.90%	4.50%	48.50%	6.20%	33.30%	24.08%	2	16.7%	69%
Seattle	39.70%	36.90%	7.00%	54.20%	30.10%	33.58%	1	15.4%	46%
Norfolk	10.60%	17.80%	29.00%	3.50%	14.50%	15.08%	4	8.4%	56%
Houston	14.30%	33.60%	11.10%	13.30%	15.70%	17.60%	3	8.1%	46%
New Orleans	7.40%	7.10%	4.30%	22.90%	6.40%	9.62%	5	6.7%	70%

Rail cost	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	10.30%	2.80%	6.50%	11.70%	13.10%	8.88%	3	3.8%	42%
Seattle	47.40%	55.90%	53.30%	60.60%	52.90%	54.02%	1	4.3%	8%
Norfolk	10.80%	15.70%	6.80%	3.50%	3.90%	8.14%	4	4.6%	56%
Houston	21.40%	20.50%	22.30%	19.50%	22.90%	21.32%	2	1.2%	6%
New Orleans	10.10%	5.10%	11.20%	4.80%	7.30%	7.70%	5	2.6%	34%

Export container cost	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Average	Priority	SD	CV
Los Angeles	14.30%	5.50%	60.30%	29.30%	26.60%	27.20%	2	18.6%	69%
Seattle	52.40%	54.90%	22.60%	55.40%	51.30%	47.32%	1	12.5%	26%
Norfolk	6.50%	16.30%	9.80%	3.10%	9.20%	8.98%	4	4.4%	49%
Houston	18.70%	18.20%	4.10%	7.60%	7.90%	11.30%	3	6.0%	53%
New Orleans	8.10%	5.20%	3.20%	4.60%	5.10%	5.24%	5	1.6%	31%

Appendix 23 Raw quantitative results

Criteria quantitative values for alternatives. Raw results					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Total TEU	14599145	3461672	2223532	1950071	451058
Export Grain TEU	134393	43823	35243	6985	981
Empty container availability (only 20')	3827	172	338	738	246
Logistics cluster size (value of freight shipments in millions $)	$ 1,341,220.00	$ 215,515.00	$ 194,444.00	$ 1,166,608.00	$ 269,932.00
Logistics cluster size (rail shipments terminating in state in tons)	97407000	48842000	77572000	202425000	36867000
Logistics cluster size (waterbourne shipments in thousands of short tons)	220836	115598	79821	485884	510788
Logistics cluster size (airfreight and mail in short tons)	1864764.43	254237.65	174007.62	815138.23	41221.06
Free trade zone size (people employed)	9000	1500	3500	15500	2750
Quantity of logistics jobs	126285	28672	9199	38584	10786
Road weight restrictions	44000	44000	46000	44000	46000
Road congestion (average % delay of a	1.43	1.38	1.19	1.33	1.32

trip vs no congestion)					
Size of trucking industry	89279	25836	4992	48556	6570
Land cost per acre	39091	16751	21921	7542	12908
Construction cost per square foot (price index to national average)	109%	107.5%	98%	112%	102%
State tax rate	8.84%	0%	6%	0%	8%
Median wages	$ 55,870.00	$ 67,365.00	$ 44,150.00	$ 32,855.00	$ 36,964.00
Unemployment rate	7.2%	6.1%	8.2%	5.9%	7%
Business climate	116	6	90	45	98
Education level	76.8%	93.10%	86.60%	81.10%	84.80%
Local incentives	22	49	62	33	31

Appendix 24 Normalized quantitative results

Criteria quantitative values for alternatives normalized with a score in %					
Criteria	Alternatives				
	Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Total TEU	14599145	3461672	2223532	1950071	451058
Total TEU. Normalized in %	64.35%	15.26%	9.80%	8.60%	1.99%
Export Grain TEU	134393	43823	35243	6985	981
Export Grain TEU. Normalized in %	60.69%	19.79%	15.92%	3.15%	0.44%

Empty container availability (only 20')	3827	172	338	738	246
Empty container availability (only 20'). Normalized in %	71.92%	3.23%	6.35%	13.87%	4.62%
Logistics cluster size (value of freight shipments in millions $)	$ 1,341,220.00	$ 215,515.00	$ 194,444.00	$ 1,166,608.00	$ 269,932.00
Logistics cluster size (value of freight shipments in millions $). Normalized in %	42.07%	6.76%	6.10%	36.60%	8.47%
Logistics cluster size (rail shipments terminating in state in tons)	97407000	48842000	77572000	202425000	36867000
Logistics cluster size (rail shipments terminating in state in tons). Normalized in %	21.03%	10.55%	16.75%	43.71%	7.96%
Logistics cluster size (waterbourne shipments in thousands of short tons)	220836	115598	79821	485884	510788
Logistics cluster size (waterbourne shipments in thousands of short tons). Normalized in %	15.63%	8.18%	5.65%	34.39%	36.15%
Logistics cluster size (airfreight and mail in short tons)	1864764.43	254237.65	174007.62	815138.23	41221.06
Logistics cluster size (airfreight and mail in short tons). Normalized in %	59.21%	8.07%	5.53%	25.88%	1.31%
Overall score for Logistics cluster size	34.49%	8.39%	8.51%	35.14%	13.47%
Free trade zone size (people employed)	9000	1500	3500	15500	2750
Free trade zone size (people employed). Normalized in %	27.91%	4.65%	10.85%	48.06%	8.53%
Quantity of logistics jobs	126285	28672	9199	38584	10786

Quantity of logistics jobs. Normalized in %	59.14%	13.43%	4.31%	18.07%	5.05%
Road weight restrictions	44000	44000	46000	44000	46000
Road weight restrictions. Normalized in %	19.64%	19.64%	20.54%	19.64%	20.54%
Road congestion (average % delay of a trip vs no congestion)	1.43	1.38	1.19	1.33	1.32
inverted result (a smaller value gives a higher score)	0.699300699	0.724637681	0.840336134	0.751879699	0.757575758
Road congestion (average % delay of a trip vs no congestion). Normalized in %	18.53%	19.20%	22.27%	19.92%	20.07%
Size of trucking industry	89279	25836	4992	48556	6570
Size of trucking industry. Normalized in %	50.95%	14.74%	2.85%	27.71%	3.75%
Land cost per acre	39091	16751	21921	7542	12908
inverted result (a smaller value gives a higher score)	2.55813E-05	5.96979E-05	4.56184E-05	0.000132591	7.74713E-05
Land cost per acre. Normalized in %	7.50%	17.51%	13.38%	38.89%	22.72%
Construction cost per square foot (price index to national average)	109%	107.5%	98%	112%	102%
inverted result (a smaller value gives a higher score)	92%	93%	102%	89%	98%
Construction cost per square foot (price index to national average). Normalized in %	19.35%	19.62%	21.52%	18.83%	20.68%
State tax rate	8.84%	0%	6%	0%	8%
inverted result (a smaller value gives a higher score)	1131.22%	1000000.00%	1666.67%	1000000.00%	1250.00%

State tax rate. Normalized in %	0.06%	49.90%	0.08%	49.90%	0.06%
Median wages	$ 55,870.00	$ 67,365.00	$ 44,150.00	$ 32,855.00	$ 36,964.00
inverted result (a smaller value gives a higher score)	1.78987E-05	1.48445E-05	2.26501E-05	3.04368E-05	2.70533E-05
Median wages. Normalized in %	16%	13%	20%	27%	24%
Unemployment rate	7.2%	6.1%	8.2%	5.9%	7%
Unemployment rate. Normalized in %	20.93%	17.73%	23.84%	17.15%	20.35%
Business climate	116	6	90	45	98
inverted result (a smaller value gives a higher score)	0.00862069	0.16666667	0.01111111	0.02222222	0.010204082
Business climate. Normalized in %	4%	76%	5%	10%	5%
Education level	76.8%	93.10%	86.60%	81.10%	84.80%
Education level. Normalized in %	18.18%	22.04%	20.50%	19.20%	20.08%
Local incentives	22	49	62	33	31
Local incentives. Normalized in %	11.17%	24.87%	31.47%	16.75%	15.74%

Appendix 25 Values of alternatives prior to the distribution

Criteria	Distributive Priority	Synthesis of the priorities of the alternatives				
		Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Total TEU	0.0046612	0.64354584	0.1526	0.098015656	0.08596	0.019883116
Export Grain TEU	0.04179904	0.60694592	0.1979	0.159164503	0.03155	0.004430394
Empty container availability	0.0272084	0.71922571	0.0323	0.063521894	0.1387	0.046231911
Flexibility	0.0094308	0.3484	0.296	0.1288	0.1472	0.0796
Long term growth of business	0.02530056	0.2408	0.3358	0.1508	0.176	0.0962
Logistics cluster size	0.091154324	0.34487027	0.0839	0.085061008	0.35144	0.134721216
Free trade zone size	0.043049364	0.27906977	0.0465	0.108527132	0.48062	0.085271318
Quantity of logistics jobs	0.029552524	0.59142681	0.1343	0.043081405	0.1807	0.050513755
Rail Cost	0.14663584	0.0888	0.5402	0.0814	0.2132	0.0777
Export container cost	0.11596416	0.272	0.4732	0.0898	0.113	0.0524
Road weight restrictions	0.22568084	0.19642857	0.1964	0.205357143	0.19643	0.205357143
Road congestion	0.05125992	0.18530756	0.192	0.222680515	0.19924	0.200749858
Size of trucking industry	0.03485924	0.50948737	0.1474	0.028487785	0.27709	0.037492938
Land cost per acre	0.05144832	0.07502743	0.1751	0.133793953	0.38888	0.227215466
Construction cost per square foot	0.03089856	0.19349695	0.1962	0.215215995	0.18831	0.206776152
State tax rate	0.02249632	0.00056447	0.499	0.00083165	0.49899	0.000623738
Median wages	0.01830752	0.15855917	0.1315	0.200650074	0.26963	0.239657525
Unemployment rate	0.00390544	0.20930233	0.1773	0.238372093	0.17151	0.203488372
Business climate	0.01035496	0.0393954	0.7616	0.050776295	0.10155	0.046631291
Education level	0.00632632	0.18181818	0.2204	0.205018939	0.192	0.200757576
Local incentives	0.01021328	0.11167513	0.2487	0.314720812	0.16751	0.157360406

Appendix 26 Final distributed values of alternatives

Criteria	Distributive Priority	Synthesis of the priorities of the alternatives				
		Los Angeles	Seattle	Hampton Roads	Houston	New Orleans
Total TEU	0.0046612	0.002999696	0.000711272	0.000456871	0.000400682	9.26792E-05
Export Grain TEU	0.04179904	0.025369757	0.008272595	0.006652923	0.001318579	0.000185186
Empty container availability	0.0272084	0.019568981	0.000879505	0.001728329	0.003773689	0.001257896
Flexibility	0.0094308	0.003285691	0.002791517	0.001214687	0.001388214	0.000750692
Long term growth of business	0.02530056	0.006092375	0.008495928	0.003815324	0.004452899	0.002433914
Logistics cluster size	0.091154324	0.031436417	0.007648156	0.007753679	0.032035651	0.012280421
Free trade zone size	0.043049364	0.012013776	0.002002296	0.004672024	0.020690392	0.003670876
Quantity of logistics jobs	0.029552524	0.017478155	0.003968275	0.001273164	0.005340121	0.001492809
Rail Cost	0.14663584	0.013021263	0.079212681	0.011936157	0.031262761	0.011393605
Export container cost	0.11596416	0.031542252	0.054874241	0.010413582	0.01310395	0.006076522
Road weight restrictions	0.22568084	0.044330165	0.044330165	0.046345173	0.044330165	0.046345173
Road congestion	0.05125992	0.009498851	0.009843012	0.011414585	0.01021305	0.010290422
Size of trucking industry	0.03485924	0.017760342	0.005139576	0.000993063	0.009659284	0.001306975
Land cost per acre	0.05144832	0.003860035	0.009007978	0.006883474	0.020006979	0.011689854
Construction cost per square foot	0.03089856	0.005978777	0.006062202	0.006649864	0.005818631	0.006389085
State tax rate	0.02249632	1.26985E-05	0.01122544	1.87091E-05	0.01122544	1.40318E-05
Median wages	0.01830752	0.002902825	0.002407494	0.003673405	0.004936261	0.004387535
Unemployment rate	0.00390544	0.000817418	0.000692534	0.000930948	0.000669828	0.000794712
Business climate	0.01035496	0.000407938	0.007886798	0.000525787	0.001051573	0.000482865
Education level	0.00632632	0.00115024	0.001394366	0.001297015	0.001214641	0.001270057
Local incentives	0.01021328	0.001140569	0.002540359	0.003214332	0.001710854	0.001607166

Synthesis of overall priorities	1	0.250668219	0.26938639	0.131863095	0.224603644	0.124212475
Priorities		**2**	**1**	**4**	**3**	**5**

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