Christaller’s Central Place Theory

Central place theory is a spatial theory in urban geography that attempts to explain the reasons behind the distribution patterns, size, and a number of cities and towns around the world. It also attempts to provide a framework by which those areas can be studied both for historical reasons and for the locational patterns of areas today.

Central Place Theory was given by Walter Christaller in 1933, which is one of the most appreciated theories that tries to explain the spatial arrangements and distribution of human settlements and their number based on population and distance from another human settlement. Christaller submitted his dissertation on "The Structure of Settlements in the Southern Germany" in 1932 to the University of Erlangen in 1932. His work was published in 1933. He found that in spite of the even distribution of settlements one may find a regular pattern in them, There is some sort of relationship between distribution, size and number of settlements and on the basis of this relationship he called these laws as 'spatial economic geographical laws' or 'the laws of geography of settlements'. His theory was based on the study of settlement patterns in southern Germany made by Christaller. This study included the analysing the relationships between settlements of different sizes and related their economic activities (market) with the population. Central place theory explains.

- Relationship between the size, the number and the geographic distribution of cities.
- Central place has the main function to supply goods and services to the surrounding population (Market Area)
- Based on concept of Range (it is economic, not mathematical)

Christaller explained why the highest order settlement has very peculiar activities which can only be supported by them and the reason behind those activities taking place only in those particular highest order settlements, he also explained the nature of activities in different order of settlements. Central place theory is of great importance even after decades and forms the basis of various present-day theories used in urban planning.

- The theory is essentially static, explaining the existence of a regional spatial structure but failing to explain how that structure has evolved and it might change in the future.
• It serves a useful role identifying important concepts such as the interdependence of a city and region, a hierarchy of functions and centres, and market range and threshold populations.

• Range also depends on the type of demand of the central good. If the demand is inelastic (urgent, non-substitutable; e.g. Hospital), then the range is large and if the demand is elastic then range is smaller (e.g. Cinema)

• Larger the central place, the greater will be the range as compared to smaller central places. (lower production cost leads to larger amount of sales).

• Higher the population density implies greater range, as again higher density make production cheaper.

In Christaller’s model, each settlement is situated in the centre of the region it serves. Logically (assuming no restrictions), this should result in a circular complementary (market or service) region. If we assume that the threshold for customers who shop in hardware stores is fifty miles, then it would follow (in keeping with Christaller’s assumptions) that on a flat plane, we should be able to find hardware stores in centres located fifty miles apart. Such an arrangement on the landscape, however, would leave areas that are not served by any hardware facilities. Thus, the most efficient shape for a service area (in the Christaller model) is not a circle, but a hexagon.

If Christaller had built his model around circular service areas, it would have resulted in a situation in which the service areas overlapped, or if they did not overlap, some people could not gain access to service. The first case would result in two or three centres competing for the same market area, and thereby would bring about a distortion of the model that could result in a failure to reach a minimum customer threshold for many of the centres. In such a situation, the model would not be useful as a tool of spatial investigation. Thus, Christaller decided to use a hexagonal pattern, and to set threshold limits within the perimeters of these hexagons. Under such idealized conditions, the arrangement of central places is geometrically predictable, and all complementary regions are of the same size and shape. Additionally, the hexagons interlock into one another, and form a nested hierarchy as well. Thus, each central place is equidistant from six surrounding centres.

In this simplistic situation, the central-place theory model is deterministic. It is deterministic, because if one knows the location and the range of two central places, he or she also knows the location of all other places on the plane.

Hexagonal lattice reflects two basic concepts of the theory: the minimum market - threshold and maximum distance - range. The minimum market is the lower limit of spatial
expansion of a particular service. The upper limit is then the maximum distance from the centre (from the service provided) which consumers are prepared to travel to acquire service. The space determined by the upper limit is a sphere of influence. The size of the centres affects the type of service which the centre provides.

Assumptions of Christaller’s Central place theory

Christaller made some assumptions to make his theory easy to understand and form the basis for other theories. These assumptions were necessary and hold good to explain the structure of settlements. These also take into account the growth and development of towns, human behaviour and fundamentals of economics. Walter Christaller made following assumptions:

- **An even (flat) terrain** – A hilly and uneven terrain poses difficulty in development thus a flat area which promotes the growth of the town
- **Evenly distributed population** – residents are not concentrated at one particular place and no preference exists for a particular town
- **Evenly distributed resources** – no place has an advantage of resources, all placed will compete under perfect market conditions
- **Similar purchasing power** – along with the population and resources, wealth is also fairly distributed. Because of this people have similar purchasing power
- **Preference for the nearest market** – people will buy products from the nearest market and avoid the long commute. This keeps price constant as per other assumptions
- **Equal transportation cost** (proportional to distance) - the cost incurred in transporting of goods is equal for all and is proportional to the distance
- **Perfect competition** – price is decided on basis of demand and supply. People will buy at the lowest price which market has to offer; no seller has an advantage over another seller.

These assumptions when combined, results in place offering different services. In these places in which people enjoy the perfect market and purchase from the nearest place to save on money and time. Different services locate themselves on the basis of the threshold population. The minimum number of people required to sustain that service/activity. In addition to this, there is no preference for a particular shop. All people have access to equal resources and do not enjoy any advantage over its competitor. The demand for goods consumed & used on daily basis will be used more and vice versa.

**Explanation of terms:** Central Place definition, low order, high order, sphere of influence
1. A **Central Place** is a settlement which provides one or more services for the population living around it.

2. Simple **basic services** (e.g. grocery stores) are said to be of low order. Specialized services (e.g. universities) are said to be of high order.

3. Having a **high order service** implies there are low order services around it, but not vice versa.

4. Settlements which provide **low order services** are said to be low order settlements.

5. Settlements that provide high order services are said to be high **order settlements**.

6. The **sphere of influence** is the area under the influence of the Central Place.

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**Two main concepts of Central Place Theory**

As per Walter Christaller, Central Place Theory is based on **TWO** fundamental concepts which are “Threshold” and “Range”

**Threshold** – The **minimum population** needed to make a service viable at a particular place. If this size is not reached then a particular activity will not start or it will be closed down.

**Range** – This is the **maximum distance a consumer is willing to travel** to purchase good or avail a service, beyond this distance consumer will not travel as the distance travelled for good/service will outweigh the benefit. Range has two limits; Upper Limit denotes an area beyond which there will be no buyer willing to travel. And, Lower Limit denotes an area need for a firm to make profits and have sufficient demand.

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**Sizes of Settlements, Communities as per Central Place Theory**

Walter Christaller gave a system with **FIVE sizes of settlements** based on the population. The smallest unit is Hamlet which is considered a rural community and the largest unit is Regional Capital.

The rank order of central places in ascending order include:

1. Hamlet
2. Village
3. Town
4. City
5. Regional Capital / Metropolis

Markets and Services tend to be nested hierarchies with smaller towns serving smaller markets. However, transportation and border effects can shift the distribution of towns away from theoretical uniformity.

![Christaller's Hexagonal Arrangement](image)

**Fig. 2: Christaller's Hexagonal Arrangement**

The Arrangement of the Central Places/ Settlements:

As transport is equally easy in all direction, each central place will have a circular market area as shown in C in the following diagram:

However, the circular shape of the market areas results in either un-served areas or over-served areas. To solve this problem, Christaller suggested the hexagonal shape of the markets as shown in D in the above diagram. Within a given area there will be fewer high order cities and towns in relation to the lower order villages and hamlets. For any given order, theoretically, the settlements will be equidistant from each other. The higher order settlements will be further apart than the lower order ones.

![Arrangement of Settlements](image)

**Fig. 3: Arrangement of Settlements**
**Principles in the Arrangement of the Central Places**

Christaller’s theory gives **THREE** principles which are the marketing principle, transport principle and administrative principle for orderly arrangements and the formation of hierarchy. Settlements are regularly spaced – equidistant spacing between same order centres, with larger centres farther apart as compared to smaller centres. The market area is hexagonal shaped as it is free from overlapping, most efficient in both number and function. Three Principles of Christaller for determining distribution of central places in a region.

- **Marketing Principle**: If the distribution is entirely based on the range of the good, then it would result in evenly spaced central places with hexagonal markets area.
- **Traffic Principle**: If any central place (city) is smaller in size than expected than it be because of lower accessibility (not falling on major transport route) and vice-versa
- **Separation Principle**: Spacing and sizing of Central places can sometimes be distorted due to socio-political consideration.

The different layouts predicted by Christaller have **K-values** which show how much the Sphere of Influence of the central places takes in - the central place itself counts as **ONE** and each portion of a satellite counts as its portion:

1. Marketing Principle (K=3)
2. Transport Principle/Traffic Principle (K=4)
3. Administrative Principle (K=7)

**Three Principles of Central Place Theory are as Follows:**

**Marketing Principle (K=3):**

As per this the market area of a higher order occupies one-third (1/3 part) of the market area of each of the consecutive lower size place(node) which lies on its neighbour. The lower size nodes (6 in numbers and 2nd larger circles) are located at the corner of the largest hexagon around the high-order settlement. Each high-order settlement gets 1/3rd of each satellite settlement (which are 6 in total), thus \( K = 1 + 6 \times 1/3 = 3 \).

With K=3 the transport network is not efficient even when the distance travelled is reduced. This is
because of the absence of transport links (network) between the larger places (nodes).

**Transport Principle (K=4):**

This provides for most efficient transport network. High order place half of the market area of 6 neighbouring lower order places located on the edge of the hexagon formed by high order settlement. There are maximum central places possible. These are located on the main transport routes connecting the higher order centre. The transportation principle involves the minimization of the length of roads connecting central places at all hierarchy levels. In this system of nesting, the lower order centres are all located along the roads linking the higher order centres. This alignment of places along a road leads to minimization of road length. However, for each higher order centre, there are now four centres of immediate lower order, as opposed to three centres under the marketing principle.

![Fig. 5: Transport Principle](image)

**Administrative Principle (K=7):**

According to $K = 7$ administrative principle (or political-social principle), settlements are nested according to sevens. The market areas of the smaller settlements are completely enclosed within the market area of the larger settlement. Since tributary areas cannot be split administratively, they must be allocated exclusively to a single higher-order place. Efficient administration is the control principle in this hierarchy.

![Fig. 6: Administrative Principle](image)

**Hierarchy of Central Places**

Christaller suggested that the central places, providing goods and services to the surrounding areas would form a hierarchy. A large number of widely distributed small places would provide lower order goods and services to service regular widespread demand. There would be a smaller number of larger centres providing both lower-order and higher-order goods and services. Successive steps of the hierarchy would consist of larger central places providing even higher-order goods and services.
Complementary Regions

Each town or city exerts its influence over surrounding areas. People come from the surrounding area to the town for goods, services, and jobs. The area over which the town exerts its influence has been termed complementary region. The term market area used in the context of specific goods and services. The larger the town, the larger is its complementary area. The larger the city, the greater the likelihood of very specialized goods and services. This attracts people from all over the world. For example, the largest cities like New York, Paris London, and Rome attract people from across the globe. Their complementary areas are international.

Example

Southern Germany displays a 7-level hierarchy of central places.

<table>
<thead>
<tr>
<th>Grade of town</th>
<th>Population (approx.)</th>
<th>Centrality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landstadt</td>
<td>50,000</td>
<td>1200 – 3000</td>
</tr>
<tr>
<td>Provinzstadt</td>
<td>1,000,000</td>
<td>150 – 1200</td>
</tr>
<tr>
<td>Gaustadt</td>
<td>30,000</td>
<td>30 – 150</td>
</tr>
<tr>
<td>Bezirkstadt</td>
<td>10,000</td>
<td>12 -30</td>
</tr>
<tr>
<td>Kreisstadt</td>
<td>4,000</td>
<td>4 -12</td>
</tr>
<tr>
<td>Amtort</td>
<td>2,000</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Marktort</td>
<td>1,000</td>
<td>- 2</td>
</tr>
</tbody>
</table>
*Centrality* is operationally defined by Christaller as the number of telephones in a central place minus the place’s population multiplied by the average density of telephones per population in the region. The highest order centres, those with the greatest centrality index were Frankfurt, Nuremberg, Stuttgart, Strasbourg, Zurich, and Munich.

**Criticism & Limitations of Central Place Theory**

*Central Place Theory is widely appreciated and used but has its own limitations.* These include the assumptions which are unrealistic. The basic assumptions are flawed. It is nearly impossible to have very large flat terrain, perfect market, and absence of preference for shopping places. Today’s economy is a capitalist economy, but government plays an equally important role which has a strong influence on the market and the location of activities. Moreover, the resources are never equally distributed, and some enjoy disproportionate benefits. Same is true for purchasing power. Thus, to make it functional as per actual scenario various modifications are required in the basic theory. Theory relates only to the service sector.

Many geographers have greatly criticized the central place theory of Christaller and its hexagonal arrangement. Some have even doubted the evidences and methods which Christaller has used. Some have called it a purely theoretical deductive model. Some considerable criticism of this theory are as follows:

1. Some critics say that the central place theory may be disrupted by various local factors such as topography, intensive agriculture, soil, productivity, transportation routes etc.
2. Transport route do not radiate in all directions from the centre of the central place or town as said in this theory. Thus, the service areas may be elongated rather than hexagonal.
3. Christaller’s criteria for determining typical size settlements and their normal number apparently do not fit actual frequency counts of settlements in may almost uniform regions as well as some less rigidly deductive norms.
4. Hans Bobeck (1938) claims that Christaller's proof is unsatisfactory. He stated that two-thirds of the population of Germany and England live in cities and that only one-third of these cities in Germany are real central places.
5. Christaller’s central place theory can be applied only to regions which are plain areas. But in regions of deep valley and ridges the central places are not symmetrical. Similarly, situations of roads, railways, rivers, industrialization etc. greatly influence the central place theory.
6. The hexagonal pattern of Christaller had been also criticized because he has neglected linear pattern along rail-road and rives and so this theory has been called purely
theoretical.
6. Most of the geographers thinks that the central place ranking and hierarchy cannot be applied to all regions. The formula of \( k = 3 \) cannot be applied in all regions.
7. Christaller’s central place theory is based on unreal assumptions, so that this theory does not appear practical.
8. The telephone index used by Christaller is highly criticized because it is no long valid and useful criteria now.

Christaller’s theory inspired many followers to further modify it. Some of these include August Lösch (1906-1945) who assumed the motivation of actors will be sparked by maximizing profit via monopoly standing which will fail to lead to equilibrium in the market. Lösch abandoned some of the simplifying assumptions of Christaller - he did not, for instance, add the functions of lower-order centres automatically for higher-order centres, experimented with industrial and agricultural sectors, used other geometric shapes besides hexagons and he built his model starting with the lowest-order centres. Due to this, the centres could specialize and differentiate their supply from other centres. His efforts are reflected in a model in which there is a dominant centre divided into sectors with a different number of centres of lower-order.
LOSCH’S MODEL

The concept of central place was originally developed by a German geographer called Walter Christaller in (1933). However, the theory was thereafter modified by a German economist August Losch in 1954 who created significant theoretical extension of the Christaller model. In his book ‘De Raumliche Ordnung der Wirtschaft’, published shortly before his death, he presented the ways in which spatial demand cones are derived and verified the optimal hexagonal shapes of complimentary areas where the population served was uniformly distributed. His main contribution was to extend the notion of Christaller’s fixed K hierarchies.

Losch accepted all the hexagonal networks presented by Christaller and extended them to higher orders by superimposing them on a common central place which is the hub of the settlement system. He considered it as a single most important city which dominates the trade and many other services in the whole of the surrounding area.

Each of the network was then rotated about this common central city until as many as possible of the higher-order services considered in the same centres. Such an arrangement ensures that the sum of the minimal distance between settlements is small and that not only shipments, but transport lines, are reduced to a minimum.

Fig. 1. Central Place System of Losch

To understand the process adopted by Losch in describing his central place system one can envisage by imaging that the fixed K=3 network is drawn on an overlay of transparent tracing paper. The overlap map of K=4 network is pointed to the K=3 map through the common central place. When the overlay is rotated, many major places on both the K = 3, and the K = 4 map are made to coincide. For example, if we have a K = 3 school system and a K = 4 hospital
system, we try to rotate the overlay so that the high school and the doctor’s hospital both coincide in the same locations rather than being split between two. Losch went on to add the K=7 and still higher K networks to the map, always trying to get as many services as possible to overlap in the same locations. Although Losch used the same basic hexagonal unit and the same K concept as used by Christaller, but he evolved a considerably different hierarchy. Christaller’s hierarchy consists of several fixed tiers in which all places in a particular tier have the same size and functions of the smaller central places.

Losch based his argument on the fact that Christaller’s model was too rigid. Christaller’s model delineates patterns where distribution of goods and accumulation of profit was entirely a function of transportation and location. Losch’s modification however focused on creating an ideal milieu for consumers and maximizing consumers welfare so that the need to travel to receive goods was minimized and profits held at a constant level rather than being inflated. The model emphasizes profit maximization in its locational analysis. According to Losch, the best location of a firm lies where net profit is greater. (Net profit is the difference between sales income and production cost). Firms look to identify a zone of profitability. Losch’s model itself consist of superimposed hexagons in a pattern around a capital or central city. These hexagons show the land around industries in order to determine at which location the population will have the lowest cost. At the place of intersection of these hexagons, smaller locations could be built so as to maximize the profit earned by each company. The major reason why Losch chose hexagon instead of a circle is because hexagons can tile a plain but circles cannot. Losch asserted that from any capital or large city, a cone emanates from it. The point where two cones meet forms the boundary where the population is divided and the plain is then tiled according to these intersections to show the region in which a central city can create profit. This model as described above would represent only one producer demand. Where there are multiple demands, more hexagonal fields can be created in similar way to illustrate the varying demands for a product.

ASSUMPTIONS OF THE MODEL

The model has the following assumptions:

1. There is an isotropic plain of flat land throughout the plain so no barrier would exist to hinder people’s movement across it.
2. There is a homogenous preference among people since people will always purchase goods from the nearest place possible.
3. That there is a hexagonal hinterland but reject even spread of population.
4. Consumers bear the burden of shipping in terms of cost.
5. That people act economically rationally.
6. That new production plants could enter market if profitable.

Fig. 2. Market, Transport & Administrative Principles by Losch
CRITICISMS OF THE MODEL

The model has been criticized on the following grounds:

1. The hierarchical system would be distorted by the location of primary or manufacturing industry.
2. It has been criticized as being static and not dynamic.
3. The assumption that consumers will act rationally and patronize the nearest centre is not correct.
4. The model determines one superior centre as most profitable; it may have been the same over a larger area.

August Losch postulated that there is one superior centre where all goods are produced. The size of the small centres increases with distance from the central place and those small centres tend to be located about half way in between larger ones. Losch opined that the size of the hexagon is not only related to a geographical centre but also related to the goods produced. Thus, a particular centre may have several hexagonal markets for its different products as transport cost is a function of distance, a particular industry X with lower cost transport will have a bigger hexagonal market area than Y given the same economics of scale.

Both Christaller and Losch’s model agree that the triangular arrangement of production site or retail stores and hexagonal market areas represent an optimum for a single good under the assumption of uniform densities on an unbounded plain with equal access in all direction.

Comparative Analysis of the Models given by Christaller and Losch

Christaller’s models are based on the assumption that the k values, once adopted, would be fixed; that is, they applied equally to the relationships between villages and towns, towns and cities, cities and metropolitan places, and so on, through all the tiers of the central place hierarchy. Losch used a similar hexagonal unit for his central place model but he improved and extended Christaller’s form.

The major difference between the two approaches was that Losch regarded the fixed k assumption as a special limiting case. Losch developed variable k hierarchies by allowing various hexagonal systems to coexist. This was achieved by superimposing the hexagonal network for one level of central places upon the network for another and then rotating the networks until the maximum degree of spatial association of central places was obtained. The reason for doing this was to minimize the route distances necessary to link the settlement pattern; as a result, it increased the efficiency of the spatial organization. In this manner, Losch generated a pattern of sectors radiating from the largest urban centre (the highest order central place) in a given region.
The Loschian landscape is composed of city rich sectors alternating with sectors containing few urban places. This tendency of the urban system to form a sort of radial banding around the highest order central place is in reality reinforced by transportation patterns.

While in Christaller's model hexagonal market areas are arranged in a nested pattern with the market areas of lower order goods packed within those of higher order goods, in Losch's model there is a much more complex web of interconnected market areas. Specifically, the Loschian spatial organization is characterized by a less distinct hierarchical structure than that proposed by Christaller because

(1) central places of the same size do not necessarily perform the same range of functions,
(2) higher order central places need not have all of the functions of lower order centres, and
(3) the city-size distribution is more likely to follow the rank-size rule.