Trade areas and knowledge-intensive services: the case of a technology centre

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Abstract

Purpose – This study aims to analyse the provision of knowledge-intensive services (KIS) by technology centres based on approaches used in the literature on trade areas.

Design/methodology/approach – The techniques employed derive from the literature on trade areas (customer spotting and ring studies) and spatial analysis (nearest neighbour analysis, Ripley’s K statistic and median centre).

Findings – The research demonstrates that there is a geographic factor in the distribution of firms associated with a technology centre and some of their characteristics depend on their proximity to such a centre. Trade areas are determined and access facilities are detected. It has also been observed how geographic proximity is coupled with functional (sector) factors in the firm-technology centre relationship.

Practical implications – These findings may contribute towards strategies for locating technology centres, and may be extended to future centre networks and to the development of more efficient marketing strategies aimed at attracting and acquiring client firms.

Originality/value – To date, little is known about the spatial distribution of firms associated with technology centres, nor are there studies that relate the profile of user firms in relation to the distance from their premises to the technology centre. Using methodology previously applied to trade areas, this research has identified the spatial pattern of associated firms which may be of use for a variety of purposes.

Keywords Knowledge intensive services, Technology centres, Trade areas, Spatial pattern, Distance, Knowledge organizations, Geography

Paper type Research paper

Introduction

In the field of retailing, a large body of literature addresses the topic of retailer trade areas. These areas are considered to be the zones in which outlets generate their sales (Applebaum and Cohen, 1961; Rosenbloom, 1976; Baray and Cliquet, 2007). A considerable amount of research has also gone into attempting to define retailer customer profiles, since local market potential and purchasing power depend on the demographic profile of the trade area (Bearden et al., 1978; Mulhern and Williams, 1994; Grewal et al., 1999).

This study applies the same approach to Knowledge-Intensive Services (KIS) provided by technology centres (Den Hertog, 2000; García-Quevedo et al., 2011), and its objectives are two-fold. The research first defines the trade areas of a technology centre in order to specify the geographic area where the centre can attract firms, offer them its services and “generate sales”; and second, determines the existence of a business
profile amongst user firms to establish whether any of their features act as a moderating factor on their distance from the centre. This aspect may reveal to what extent distance has an influence on different sized firms in their relationship with the technology centre.

The study was conducted by taking the example of the AINIA (Asociación de Investigación de la Industria Agroalimentaria) technology centre in the agrifood industry and the firms connected to it. Despite the focus on a case study, the findings may have a more general application, since this type of technology centre is being extended to other countries.

The paper is structured as follows. The first section presents and defines the theoretical framework relating to retailing and KIS centres, which leads onto the presentation of the research questions we are attempting to answer. A description of the methodology precedes the analysis of the findings of the study, which ends with the main conclusions to be drawn from this contribution to knowledge on KIS and their relation to trade areas.

Trade areas

The trade area or market area of a retail establishment can be defined as the geographic area in which the retailer generates all of its sales during a specific period of time (Applebaum and Cohen, 1961). Huff (1964) described it as the geographically defined region that contains potential clients whose likelihood of purchasing a particular product or service offered by a specific company or by a group of firms is greater than zero. In other words, the trade area or market area of a retail establishment is the geographic area in which it is able to attract customers and generate sales. If retailers are able to identify where customers reside and reflect this information on a map, they can then establish the distance these customers are willing to travel to patronise the outlet.

Previous studies have attempted to determine these trade areas more precisely. Thus, according to Bainbridge (2003), the trade area of a typical traditional store is usually considered to be a two-mile (3.22 km) radius in urban areas. Alternatively, in small rural communities the trade area often covers a larger proportion of the town or even the entire town. For stores located close to motorways or main roads, their trade area could extend over several miles along a traffic route.

This precise knowledge of trade area boundaries is of vital importance for retailers as it enables them to adjust their marketing strategy to their customer features. Studies by Hoch et al. (1995), Montgomery (1997) and Mulhern et al. (1998) show that the demographic profile of the trade area of a retail outlet can greatly affect customer reaction to the pricing strategy and sales promotion campaigns conducted by the retailer. Therefore, not only are the customers and the competition important, but also their exact location, and the that of the establishment itself (Baviera-Puig et al., 2009).

An indispensable starting point for this type of marketing exercise is a definition of the trade area itself. Applebaum (1966) states:

• The primary trade area is that which encompasses approximately 60 per cent to 70 per cent of consumers. It is the closest area to the establishment and has the highest density of customers.
• The secondary trade area is adjacent to the first one and consists of the next 15 per cent to 25 per cent of the total number of customers.
• The tertiary trade area comprises the remaining clientele.
This classification of trade areas implies a decrease in the number of customers the greater the distance from the establishment. This phenomenon is in line with Reilly’s law of retail gravitation (Reilly, 1931) and Huff’s spatial interaction model (Huff, 1963, 1964). Both approaches define the drawing power of a retailer as being directly proportional to its size and inversely proportional to the distance from the consumer.

In addition to these approaches, Grether (1983) argues that employing spatial analysis should form part of the theoretical framework of marketing since spatial organisation and relations are organically linked. Similarly, Andrienko et al. (2007) suggest using this type of analysis for long-term strategic business planning.

Knowledge-intensive services (KIS)

KIS encompass a wide variety of activities and services, including marketing, legal services, consulting, engineering, technical analysis, and others (Mas-Verdú et al., 2011). One intrinsic feature is that they are a source of innovation in themselves and for the businesses that use them.

For businesses, the importance of KIS is evidenced through their role as catalysts (Den Hertog, 2000, 2002), promoting the connection between their tacit and generic forms of knowledge. The former is based on the firms’ specific experience while the latter is more easily codified. Nevertheless, KIS not only contribute towards innovation in businesses, but also globally in the productive system. This is why KIS play such a crucial role in economic development (Mas-Verdú et al., 2011).

Some public policies have focused on providing advanced services through the creation and promotion of technology centres as KIS providers. It has been shown that these centres promote business innovation wherever they have been established (Garcia-Quevedo et al., 2011). Problem solving for client firms by the technology centres can lead to the development of new knowledge resulting in a mutual transfer of expertise (Den Hertog, 2002). Thus, the provision of KIS can be considered a “collaborative learning process” (Aslesen and Isaksen, 2010).

In this sense, many authors underline the importance of geographic proximity for the transfer of this knowledge (Audretsch, 1998; Barrio and Garcia-Quevedo, 2005). This is because spatial proximity engenders innovation since it facilitates co-operation, exchange of knowledge, reciprocity and trust (Todtling and Kaufmann, 2001).

However, to date, little is known about the spatial distribution of firms connected with a centre, nor is there any available analysis which links user firm profiles with their distance from the technology centre that provides them with KIS services.

AINIA, the technology centre selected for this study, comprises more than 1,100 firms in the food sector and related industries. The centre is a private, not-for-profit association with the mission of promoting innovation, research and technological development.

Research questions

Based on a review of the literature and the gaps in existing knowledge, the questions we have posed in this research paper are as follows:

RQ1. As previously stated, in retailing, a reduction in the number of customers is observed as the distance from the retailer increases (Applebaum, 1966). If the pattern for firms connected to a technology centre were similar (in that their number diminishes as the distance from the centre increases), Reilly’s law
(Ó hUallacháin and Leslie, 2007) or Huff’s model (Huff, 1963, 1964) may be applicable. If this were the case, it would be possible to delineate the boundaries of the technology centre’s trade areas, define the geographic scope of its business and identify barriers or ease of access. Thus, the issue to be explored is to determine whether the distance variable has a bearing on the spatial distribution of firms around a technology centre.

RQ2. Just as a customer profile has a bearing on purchasing behaviour and response to retailer marketing strategy (Zeithaml, 1985), the question that arises is whether the profile of client firms of a technology centre also has a bearing on their decision to acquire KIS. Additionally, we could also determine whether the different variables considered (age, size, etc.) have different effects in terms of spatial distribution. This would lead us to consider whether these variables could act as moderating factors on the distance from the technology centre of the firms associated with it. The research objective would thus be to establish which company features have an influence on the spatial distribution around a technology centre.

The variables considered in the analysis can be split into two groups: profile and performance. The first group of variables corresponds to the firms’ main features (“Profile”). These variables are sector, age and size. The second group of variables refers to the results obtained by the firms (see analysis conducted in other service sectors, Montoro et al., 2010). These variables include income, turnover, productivity and profitability. This business data has been extracted from the SABI database.

The relationship between age, size and other variables compared with a firm’s capacity to absorb innovation has been explored in various research studies (Fariñas and Moreno, 2000; Mata and Portugal, 2004) but rarely in the context of distance.

Methodology
The methodology employed can be divided into two main sections. The first attempts to define technology centre trade areas, while the second encompasses spatial analysis techniques.

In the first group, a wide range of techniques exist for determining trade areas (Albaladejo, 1995; Baray and Cliquet, 2007). For this study, Applebaum’s (1966) technique was selected. Although this technique was never greatly theoretically expanded upon, the ideas it embodies have provided the basis for many subsequent studies. This methodology is supplemented with ring studies (Bainbridge, 2003).

For the second stage, spatial distribution pattern techniques are used (Nearest Neighbour Analysis and Ripley’s K statistic), as well as measurements of the geographic distribution of the firms linked to the technology centre (median centre) in order to answer the questions raised.

Customer-spotting data and ring studies
Applebaum (1966) proposes a method for establishing the boundaries of trade areas known as the “customer-spotting technique”. The primary objective of this procedure consists of estimating the region where the establishment’s customers live, in other words, the entire trade area. The technique is applied in two steps. The first involves interviewing a significant sample of customers in order to find out their address and
shopping habits. The second step involves locating the individuals from the sample on a map of the territory, the so-called “customer-spotting map”.

Ring studies identify the areas described as circles within a specific radius, at the centre of which lies the establishment. Another option is that of drive-time studies which take into account the accessibility to the store along the existing traffic routes. The aids or barriers to access are also considered (Bainbridge, 2003).

**Nearest Neighbour Analysis**

Nearest Neighbour Analysis (Clark and Evans, 1954; Ebdon, 1977) is specifically designed to measure patterns in terms of the arrangement of a set of points. The Nearest Neighbour Ratio $R$ is calculated as:

$$\frac{R}{r_{obs}} = \frac{r_{exp}}{r_{exp}}$$

where $r_{obs}$ is the Observed Mean Distance and $r_{exp}$ is the Expected Mean Distance for a random arrangement of points. Additionally, the Observed Mean Distance is calculated as:

$$r_{obs} = \frac{\sum d_i}{n}$$

where $d_i$ is the nearest Neighbour distance for any point $i$ and $n$ is the number of points. For a theoretical random pattern, the Expected Mean Distance between nearest Neighbours is calculated as:

$$r_{exp} = \frac{1}{2n} \sqrt{\frac{n}{A}}$$

where $n$ is the number of points in the distribution and $A$ is the area of study. If $r_{obs} > r_{exp}$ or $R > 1$, it suggests that the observed pattern is more dispersed than the random pattern. In contrast, if $r_{obs} < r_{exp}$ or $R < 1$, it indicates a more clustered pattern.

**Ripley’s K statistic**

Although Nearest Neighbour Analysis describes the global pattern of a set of points, the underlying spatial process may not be homogenous over the entire study region. This is why Ripley’s K statistic is used (Getis, 1984; Wong and Lee, 2005).

The $K$-function describes the extent to which there is spatial dependence in the arrangement of events (Ripley, 1976, 1977). It identifies the scale and significance of the clustering over a range of distances. Furthermore, it captures the local variational characteristics in the study region comprehensively. The formula is as follows:

$$K(t) = n^{-2} A \sum_{t} \sum_{j \neq l} w_{ij} I_t(u_{ij})$$

where $t$ is the radius of a circle whose centre is a point in the pattern, $n$ is the number of points, $A$ is the plot area, $w_{ij}$ is a weighting factor to correct for edge effects, and $I_t$ is a counter variable which is set to 1 if the distance $u_{ij}$ between points $i$ and $j$ is $\leq t$, otherwise $I_t = 0$.

Besag (1977) proposes a linear transformation of $K(t)$ and defines the $L$ function. This new function is more often used because it is easier to interpret:
Following this formulation, under complete spatial randomness, $L(t) = 0$. If $L(t) > 0$, it indicates that the observed distribution is geographically concentrated at that distance $t$. However, if $L(t) < 0$, it denotes dispersion.

**Median centre**

The median centre is a measurement of the central tendency, which is robust to atypical spatial values. If the mean centre of the space defines the arithmetic location of a group of points $(x, y)$, the median centre identifies the location that minimises the route to the rest of the features of the dataset.

The method used for calculation is Kuhn and Kuenne’s (1962) iterative procedure, described by Burt and Barber (1996):

$$d_i^t = \sqrt{(x_i - x^t)^2 + (y_i - y^t)^2}$$

**Results**

This section sets out the findings obtained following the order of the methodology described, which are then analysed and discussed in the following sections.

First of all, customer-spotting data is conducted. In our case, the firms’ addresses were already available and the firms were directly located on the map using Geographical Information Systems (Burrough, 1988). The ArcMap 10 programme by ESRI was used in this research.

The ring study established the primary and secondary trade areas of the technology centre. 60 per cent of the firms belonging to AINIA are located within the circle within a radius of 270 km., while 80 per cent of the firms are located within a radius of 338 km. This technology centre is situated close to a motorway, which is connected to a wide high-speed road network.

When distributing the firms according to their distance from AINIA, it was observed that their number diminished the greater distance from the centre, with the exception of the firms located in the areas around Madrid and Barcelona. Since these are two large urban centres with a high density of businesses, the number of firms linked to AINIA increases. It also reveals that 40 per cent of the associated firms are situated within 90 km of the technology centre.

This spatial distribution is analysed by employing the Nearest Neighbour Analysis. Given the Nearest Neighbour Ratio of 0.34 and the z-score of -37.08, there is less than 1 per cent likelihood that this clustered pattern could be the result of random chance (Table I). Therefore, there is a spatial pattern in the global distribution of the firms and this pattern is clustered.

At a micro level, Ripley’s K statistic is used as it includes all points and distances between all points, and not just the nearest Neighbours. Marcon and Puech (2003) indicate that this function does not take of firms’ individual characteristics into account, considering each of them as a point in space, irrespective of size. Nevertheless, Ó hUallacháin and Leslie (2007) calculate unweighted and employment-weighted distance-based clustering of establishments of different sectors. So the $K$-function can...
determine whether the establishments or the values associated with them display a statistically significant clustering or dispersion pattern within a range of distances.

In the current research, the K-functions of both the unweighted and weighted points are calculated. In order to test the significance of the results, confidence envelopes are computed. These envelopes can be translated into confidence intervals at the 1 per cent level (Figure 1).

The following must be taken into account when interpreting the graph data: When the K-value observed (curve line) is greater than the K-value expected (straight line) for a distance, the distribution is more clustered than a random distribution for this distance. Equally, when the K-value observed is smaller than the K-value expected for a distance, the distribution is more dispersed than a random distribution for this distance. If the K-value observed is outside the confidence envelope, it is 1 per cent statistically significant.

From the findings obtained, two spatial distribution patterns are observed:

(1) A change in the spatial pattern from clustered to dispersed for size, income and turnover. The distance at which this change occurs is approximately 200 km.

(2) A clustered pattern for the rest of the variables for the whole range of distances measured.

<table>
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<tr>
<th>Observed mean distance</th>
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<tr>
<td>Expected mean distance</td>
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<tr>
<td>Nearest Neighbour ratio</td>
<td>0.344397</td>
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<tr>
<td>Average Nearest z-score</td>
<td>−37.078943</td>
</tr>
<tr>
<td>Neighbour test p-value</td>
<td>0.000000</td>
</tr>
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</table>

Table 1. Average Nearest Neighbour test

Figure 1. Unweighted K-function
The results are 1 per cent statistically significant for the unweighted and sector-weighted functions. However, the change in the spatial pattern is 10 per cent statistically significant for the three variables mentioned above.

For the detailed analysis of the “Sector” variable, the firms are split into three groups, based on their NACE code:

1. In group 1: sectors A and B: agriculture, livestock, forestry, fishing and extraction industries.
2. In group 2: sectors C, D, E and F: manufacturing, supplies and construction.
3. In group 3: sectors G to U: trade, transport, communications, and services in general.

Results show that group 2 is the largest of the three groups, while group 1 is the smallest. It also shows how the spatial distribution of the three groups of firms based on their distances varies widely between them. This leads to the interpretation that the distribution of firms around a technology centre depends on the sub-sector they belong to.

With regard to the calculation of the median centre for the firms (“Points”) and of the weighted firms based on the variables considered (Table II), it can be observed that those variables that denote a change in the spatial pattern are those with the greatest modification to their median centre, taking the median centre of the establishments as the reference point. The median centre of the firms weighted according to size, income and turnover moves towards the centre of the country, particularly in the province of Madrid, with the median centre of the establishments in the province of Valencia being very close to AINIA.

**Analysis and discussion**

*Location strategy*

In all of the available literature, three variables are marked as being essential to the success of retailing, irrespective of the other decisions taken during the entire commercial planning process. These three variables are location, location and location. From this we can deduce the importance of making the right decision regarding the location of retailers (Ghosh and Craig, 1983).

In view of the findings obtained, this same approach appears to be applicable to technology centres. As already indicated, these centres should preferably be located close to their clients (the firms). In this research, it has been observed that 40 per cent of

<table>
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<th>Points</th>
<th>XCoord 710.647,00</th>
<th>YCoord 4.376.160,00</th>
<th>XDesv 0,00</th>
<th>YDesv 0,00</th>
</tr>
</thead>
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<tr>
<td>Sector</td>
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<td>Age</td>
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<td>4.376.130,00</td>
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<tr>
<td>Size</td>
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<tr>
<td>Income</td>
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<td>4.477.060,00</td>
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<td>Turnover</td>
<td>456.909,00</td>
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<tr>
<td>Productivity</td>
<td>703.933,00</td>
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<td>Profitability</td>
<td>713.832,00</td>
<td>4.380.830,00</td>
<td>0,45</td>
<td>0,11</td>
</tr>
</tbody>
</table>

Table II. Median centres
the firms associated with the technology centre are located within 90 km of the centre, taking the centre as the reference point. The following 20 per cent of firms can be found within the next 180 km. The fact that the technology centre is well connected via a high-speed road network could be a factor in its services reaching a larger number of firms and in its trade areas being as large as they are.

It is also worth considering where the industrial centres are located, in the same way that retailing seeks out population centres (Applebaum, 1968). In the case studied, the spatial pattern of the associated firms is clustered, which implies that their distribution around the territory is not randomised. A further finding to be taken into consideration in this respect is that the secondary trade area includes 80 per cent of the firms and encompasses the business centres of Madrid and Barcelona, reaching a radius of 338 km.

Even so, the number of firms linked to the centre diminishes as the distance increases, except for the distance bands of Madrid and Barcelona, and as such, complies with Reilly’s law of retail gravitation (Reilly, 1931) and Huff’s spatial interaction model (Huff, 1963, 1964) relating to retailing.

Profile analysis

The aim of any location strategy is to determine the spatial pattern which best fulfils the corporate objectives of the company providing the services. It not only involves selecting the best site, but also includes a combination of the spatial features of the market together with the company’s corporate and commercial objectives (Ghosh and McLafferty, 1987). Therefore, when deciding on a location, it is important not to neglect the customer profile, since this has a bearing on firm success (Kalyanam and Putler, 1997). Moreover, it could be the case that one of the variables has a different spatial distribution.

On the one hand, in this research project, the business variable “Sector” seems to follow a cluster pattern at all the distance brackets analysed, depending on the group the company belongs to. This could be because the technology centre analysed belongs to the agrifood sector, which may determine in some way the type of company associated with it. For this reason it is likely that firms in this sector are spatially clustered within the territory. These findings coincide with those of García-Quevedo and Mas-Verdú (2008), which demonstrate that geographic proximity is not the only important factor, as functional (sector) factors between KIS providers and users are also influential.

Despite the findings being only 10 per cent significant, there are a series of variables whose spatial distribution changes as the distance grows. These variables coincide with those whose median centre is closer to the province of Madrid. These variables are size, income and turnover. In view of these findings, we could conclude that these variables may act as moderating factors on the distance from the technology centre of associated firms. In other words, it may suggest that the profile of the firms could have an influence on their decision to acquire KIS services or not.

Policy implications

The findings suggest that analysing the spatial distribution of firms could lead to a series of implications for innovation policy (Fernández de Lucio et al., 2010) for several reasons. The first is that this analysis reveals which business centres are well or poorly
served, enabling the technology centre to detect market opportunities. This is relevant when planning to open a new technology centre or representative office. At the same time, it makes it possible to forecast the number of clients or firms that may use the centre’s services, by taking into account the spatial distribution of their features (Ghosh and McLafferty, 1987).

Second, at the next decision-making level, the findings for this type of study could also be of relevance for establishing the size of future technology centre networks. Not only do they reveal where underserved firms are located, but also any duplication of services that could occur between them. In retailing, these duplications are known as cannibalisation (Kelly et al., 1993). Any duplication in the provision of services by technology centres can be detected by identifying any overlaps in their trade areas. This could result in competition for the clients residing in the trade areas of the two centres, reducing the market share for centre and client firm and in a division of efforts and resources to acquire them.

Therefore, when deciding on the size of a technology centre network, establishing trade areas appears to be essential in order to serve the largest possible number of clients with the smallest number of centres (Ghosh and McLafferty, 1982), to set out the scope for co-operation and improve coordination between them.

Third and finally, an analysis of the profiles of the firms working with a technology centre and their spatial distribution could contribute towards the design of marketing strategies for customer acquisition by these centres. This would lead to greater efficiency in their commercial strategies.

Conclusions
In this study, the methodology employed in retailing has been applied to the study of the provision of KIS by technology centres. Analysing the provision of KIS is a key factor, since it plays a crucial role in economic development by contributing towards innovation within firms themselves, but also globally within the productive system. The techniques used derive from the literature on retail trade areas (customer spotting and ring studies) and spatial analysis (Nearest Neighbour Analysis, Ripley’s K statistic and median centre).

From the findings, it can be deduced that technology centres behave in a similar way to retailers in their relationship with their client firms. On the one hand, the number of clients decreases as the distance from the technology centre increases; 40 per cent of the client firms are located at a distance of 90 km or less; it is possible to establish their trade areas and detect any possible barriers or aids to access as well as the spatial pattern, and establish that the pattern of the firms linked to the centre is clustered. This data can assist in the development of location strategies for technology centres and in establishing the size of future networks, bearing in mind nature of cannibalisation and potential business opportunities.

On the other hand, by analysing the profile of the associated firms, it can be observed that the spatial pattern of the “Sector” variable is also clustered. This suggests that not only is geographic proximity an important factor, but the functional factor (sector) is also important in the relationship between technology centres and the user firms. A change to the spatial pattern is observed for the variables of size, income and turnover. Although this result is only 10 per cent statistically significant, these variables could act as moderating factors in the relationship between technology
centres and their clients. One direct application of these findings lies in the
development of more efficient marketing strategies for technology centres.

One of the limitations of this study is that it involves a static analysis at a specific
moment in time of the spatial distribution of the firms associated with the technology
centre. In this respect, future research projects may wish to include the time variable in
the spatial analysis. A further line of research could include a comparison of the results
with the findings of other centres in other sectors, or even in other countries.

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