Municipalities worldwide, wanting both to facilitate its citizens and to attract future investments have spent an enormous amount of time, money and effort in order to develop wireless infrastructures. Hotspots for Wi-Fi have been growing exponentially in many cities around the world.

The question though, is how much the existing wireless technical infrastructure responds to the needs of the citizens of cities around the world. Apparently, in order this question to be answered, these needs must be initially identified and a correlation of those needs with the existing wireless networks must be done

Research objectives

The quality of a wireless network can be evaluated from a variety of perspectives. However, we strongly believe that the opinion of the end user stands out in importance to the task of evaluating the quality of a wireless network. Therefore, the primary objective of this paper is to discover the users' criteria of evaluation in regard with the quality of a wireless city network. The second objective that this paper pursues is to develop a ranking for wireless cities that respond to these criteria of evaluation. In order to reach the achievement of the aforementioned objectives, we have formed the following research question.

Research question

Which are the ideal criteria to define the quality of a city's wireless infrastructure taking into consideration only the users' perspective and how according to these criteria, a ranking of the wireless cities can emerge?

Scientific Relevance

There are many scientific research papers that specify the wireless technological framework of many cities worldwide and especially the city of Leiden. The Wireless Leiden organization and many students of the Master ICT in Business at the University of Leiden have written about many different aspects of the wireless Leiden.

Abstract- More and more, nowadays people are exposed to the hype of the emerging wireless networks. Many cities around the world are building wireless infrastructures in order to provide their citizens with ubiquitous network coverage. But, did the wireless architects ever think about asking people what do they really want and what it would be useful for them or they just follow some technical standards that are of no worth to the users? This research initially casts a light on these very preferences of the users leading to a framework for ranking the wireless cities worldwide and in addition through testing ranks the city of Leiden.

Keywords - Questionnaire, Users preferences, Wireless Leiden, ranking framework, Open wireless networks, Leiden's Ranking

Introduction

The use of internet has transformed dramatically the everyday experience. Internet has not only transformed the means of communication, but also has affected every single aspect of the individual's life, from the way he does business to the way he organizes his entertainment time. The world has been transformed into a global village and the new emerging wireless world will shorten even more the spatial distances. Even though space is a fixed magnitude, the wireless network adds to space an aspect that annuls and reforms the existing geographical barriers.

However, these researches do not include tow parameters that involve the end user; namely, *which* are the users' actual needs and *how* these users' have access to wireless network. One the one hand, none of those researches have included the information regarding what the citizens consider to be important for them in order to be able to perform their internet tasks easier. On the other hand, these researches have not take in account the matters considering how the users are using this wireless network.

The fact that the aforementioned parameters were not taken under consideration creates a scientific gap to the wireless network's text. This paper aims to fill up this gap as accurate as possible by taking in account the two parameters identified as not included at the research available up until now. The two parameters comprise an important addition to the research regarding wireless network academically and practically. It is important academically, because the emergence of the people's preferences on this wireless infrastructure will lead to the improvement of the wireless services. Practically it is important since, determining the abovementioned criteria will develop a users' oriented ranking. This task will initiate a constructive competition between the cities that will set wireless network to become more attractive for future investments. However, due to time constraints, and despite the fact that people from twenty three (23) countries specified their preferences, the only city to be tested and then ranked will be the city of Leiden.

Theoretical Background

The technological infrastructure of the wireless Leiden is already known and very well specified by the wireless Leiden community. Paul Nguyen[1], a student of the Master in ICT in Business at the University of Leiden, in the context of his research has identified and documented the potential usage of the wireless infrastructure for VOIP and streamlining. Richard Velden[2], another student of the same program after performing some measurements at the city of Leiden came up with a coverage map of the wireless Leiden. In addition, both the advantages and the drawbacks of the wireless Leiden have been demonstrated extensively. Furthermore, some

rankings based on the technical characteristics of wireless networks have been developed already.

Nevertheless, this research aims to form a different kind of ranking. The kind of ranking that this paper aims to resolve to is the one that will cast a light on the *preferences* of the users of the wireless network within the city of Leiden. The preferences will be based on both the end users' perceptions regarding the wireless infrastructure of a city and on the end users' actual needs in performing their communication tasks easier and more efficient. In order our research question to be implemented, the technological characteristics of the Wireless Leiden as they have been specified by previous research are taken under consideration. The achievement of the abovementioned will be facilitated with the use of statistical methods in order to obtain as precise results as possible.

Finally, the results of this research could help the existing authorities of the wireless cities to adopt their technical characteristics to the users' preferences. Since, in the end what really counts is how the society is utilizing the network; the user's preferences are valuable to the task of improving the wireless network's infrastructure.

Research strategy and methods

The wireless infrastructures in different cities around the world have been developed in order to facilitate the communication needs of their citizens. Thus, the citizens will be the major contributors to this paper. This paper aims to identify the different demographical groups of people not only in the city of Leiden but also in other countries worldwide and apply a procedure to achieve the equal participation of each group to the results of this research.

Initially, a *blank questionnaire* will be used in which the users will enumerate the most important characteristics that a wireless network should have. These characteristics will be formed either in accordance to their opinion or to their needs. This blank questionnaire will be performed in an interview format and its objective is to enable users to state their wishes without being biased by a well-structured questionnaire.

Moreover, this research will utilize an *appropriate questionnaire* that takes into account the results of the blank questionnaire. The second's questionnaire purpose is to elicit congruent results from the preferences of different demographical groups worldwide.

The results that will be obtained from the procedure described afore will be analyzed through the *appropriate statistical methods*. The statistic analysis will be utilized in order to specify different weights to each characteristic.

The aim of this paper which is to form a ranking of the city analogous to the users preferences will emerge from comparing each of these characteristics, according to their weight, with the current wireless characteristics of the city of Leiden, that will be used as a test case. Tests will be performed in the main places that users indicated in the questionnaire. The more the current wireless city characteristics will be similar to the characteristics that the citizens have specified the higher the ranking of the city will be. If no similar characteristic is found the ranking of the city will be zero.

The making of the questionnaires

Blank questionnaire / interview

A blank questionnaire under the form of real time interviews was performed. Fifty (50) people of different age groups both female and male were asked the following question:

> *When you are out of your house/office, where would it be useful for you to have internet access and for what tasks would you use it for?*

Main online-questionnaire

The answers of the interviews were used in the construction phase of our main questionnaire. The main reason was our will not to bias our sample by giving them a guided questionnaire, but to come up with a questionnaire that also takes into account our sample's raw preferences. Furthermore, the questions asked, were as simple as possible in order to lure people in making our questionnaire easily

The distribution channel was the internet. Whilst, for some groups of people group/bulk email was sent, for many others an email

addressing them individually was sent in order to attract their attention without being considered a spam.

Finally, it should be mentioned that our questionnaire were available online for one week and the recipients were informed about this duration.

Qualitative results

We were surprised by the amount of people that responded to our questionnaire having in mind both the number of people we initially sent it and the limited timeframe that they had to answer it. The recipients were very enthusiastic about the questionnaire and some of them voluntarily forwarded it to their friends. This response from people leads to the conclusion that people are very interested in the emerging wireless networks.

Demographics

Two hundred and twelve results were obtained (212) from people of different age groups, both female and male, living in 23 different countries with the majority of them living in the Netherlands and in Greece. In the *Appendix* is included a detailed description of the results.

Wireless Capacity of users

The vast majority of our respondents (74.06%) has at least one kind of a device that supports wireless networking and another 8.96% plans to buy one in the near future. This percentage shows that most of the users will be able to use the wireless networks. However there is still a considerable amount of people that don't even plan to buy any kind of device that supports wireless networking. This group of people can be indicative for the percentage of people that are not aware of either how to use wireless network or of the wireless network's facilities.

In case of ubiquitous availability where would users prefer to use wireless networks

There are several places that people would use the wireless city network but the vast majority of them would prefer to use it in *Hotels,* at the *airport*, in the *libraries* and the *means of public transportation*.

However, many users showed a preference in using wireless networks either while being in

cafeterias, while visiting *parks* or while they are in public spaces within the *vicinity of universities*.

Furthermore a significant amount of people stated that they would use internet while in *hospital, in shopping malls, restaurants, in banks* and while they are in *beach.*

There were also some people that showed interest in using wireless networking while in *stadiums*, in the *harbour* and even the *hairdresser*.

Nonetheless there was an adequate amount of people that stated that they would like to use the internet only when they are home or at office.

Internet access while traveling

The importance of the access of internet while in public transportation has been confirmed by another question that showed that the majority of people would find it very useful to have internet access while traveling.

Current situation

Although they are not connected to the city's wireless network yet, many people access the internet, connecting to a wireless or not provider, while outdoors mostly in *Hotels, Airports Libraries*, and the *public areas within the vicinity of universities.*

There is still a part of the sample that uses the internet only while at home or office however, the larger part of the sample tends to use internet in different parts of the city and therefore the emergence of wireless network will facilitate them not only for their work and leisure efficiency but also financially.

Paid or unpaid wireless access

Almost one third of the sample (29.72 %) said that they are willing to pay to access the internet when using wireless network that signifies how the need of many people to access the internet at almost any place. The larger part of our sample (41.51%) replied that they might pay under certain conditions, hypothesizing as the most probable condition in reference the amount of money for the appropriate services.

However there is also a significant amount of people (27.83%) that would definitely not pay for a wireless city network.

Voice over IP – videoconferencing (Skype)

The potential emergence of VOIP services was indeed, supported by the answers of our questionnaire. The vast majority of the respondents said that they would use video conferencing outdoors, using Skype for example, with (21.70%) claiming very frequent usage whilst (50.94 %) saying that they would use it sometimes. However there is again a minor but still important part of the people that stated no will of using it for this purpose.

Security on Open Wireless Networks

Security plays an important role on the way currently people use the internet. We wanted to find out if people know about the potential security threats on open wireless networks and what would be their reaction if they were aware of these potential threats.

The majority of the respondents (75.47%) claimed knowledge of the potential threats whilst a minor part (21.23 %) didn't even recognize them.

Almost the whole sample replied that security is either very important (50.47%) or simply important (41.51%) and only tiny part of the sample (4.72%) didn't care at all about security issues.

Although the vast majority stated the importance of security while accessing open wireless networks a surprisingly large part of the sample (29.72%) would give sensitive information to make on-line transactions despite their knowledge of the possible security threats. The larger part though (64.15%) stated their opposition in giving sensitive information when their security is not totally insured.

Open wireless networks potential usage

The largest part of the sample would access the internet using an open wireless network either for checking their emails (84.43 %) or for simply browsing the internet (71.70%). A significant amount of people (31.13%) would use it for instant messaging (MSN messenger, Yahoo Messenger etc.). In addition minor

parts would use it either for videoconferencing (18.87 %) or for making online transactions (9.91%).

Users and- flexibility

Mostly (53%) users would try to connect again and again when the want to connect to an open wireless network and they cannot succeed after failing to do so many times. However, almost one third of the people asked (31.60%), stated that they most of the times would not try to reconnect after a number of failing attempts.

Within the same context, users would usually (61.79) try to move to another neighboring place in order to find a better network coverage whilst a minor but still important group wouldn't try to find better coverage unless there is an important reason to do so.

Bandwidth
With the emergence of the web 2.0 the simple and light web pages have been transformed to heavy pages containing a broad range of formats which in order to be browsed comfortably they require adequate bandwidth capacity. Users seem to understand this current trend and therefore the vast majority responded that a high browsing speed would be either very important advantage for them (48.11%) or a considerable advantage (48.11%).

Conclusion of results
The ideal criteria to define the quality of a city's wireless infrastructure taking into consideration only the perspective of the users are related to the following:

- Locations at which the users can have wireless access to the internet

- Ability to use mail services

- Ease of use while connecting

- Security of data transmissions

- Network bandwidth

- Cost of using the wireless service

- Ability to use the wireless network for VoIP (Voice over IP) services

- Ability to use messaging services

- Network availability and range

- Access to wireless services while driving

The results of the survey can be found in detail in the appendix.

Wireless Leiden
The Wireless Leiden Foundation has established a fast, open and inexpensive wireless community network for the Dutch city of Leiden and surrounding villages. Whilst, similar initiatives exist in other cities, like Seattle, San Francisco, Portland, New York, they believe that Leiden has a unique approach with greater potential for tackling the citywide broadband problem by using a local network of wireless nodes as a backbone for others.[2] They are building a local network, technically comparable to the Internet, but standing alone and functioning independently using the 802.11b standard. It is fast, inexpensive, and extremely well suited for local communication and community Internet access. This network is free for anyone to use and functions without encryption. The underlying reason is that is that 802.11b standard operates in the unlicensed 2.4 GHz frequency band and therefore other unlicensed users can easily interfere in the same area. The unique character of their approach was recognized when the Foundation received the 2003 'Vosko Award' for network pioneers. They wireless Leiden Foundation claims it is one of the largest outdoor WiFi-networks in the world.[3]

Testing Wireless Leiden
The results of our abovementioned questionnaire that recorded the users' preferences on the wireless networks led us to the places to be measured. The results of these performance tests will be later utilized in the procedure of developing the appropriate ranking for the city of Leiden

Preparation
The Wireless Leiden official English webpage was studied in detail. In addition the wireless coverage map that Richard Velden designed within the context of his research paper for the master ICT in Business was printed out and taken to be checked.

Equipment
- Laptop: Acer Aspire 5502 ZWXMi with intel Pentium M processor 735
  - 1.7GHz, 400 MHz FSB, 2MB L2 cache
- Operating System: Microsoft Windows XP Home Edition
  - Version 2002 Service Pack 2
- Wireless: 802.11b/g wireless LAN
- Browser: Mozilla Firefox version 2
- A notebook with a pen
- A large umbrella
- Wireless coverage map of Leiden, a normal map of Leiden
- No vehicle used than my shoes…

Date
We have performed the measurements on Tuesday the 12th of June 2007 from 15:00 till 22:00 o clock. The weather was very cloudy and the humidity was very high

Tips from Wireless Leiden Foundation that taken into consideration

1. *Establishing connection*: Every time we were in the range of many Extensive Service Set Identifiers (ESSIDs) we chose the two strongest ones ending on wleiden.net and beginning with 'ap' or 'omni', e.g. 'ap-zw.cetim1.wleiden.net'. The website states that the ESSIDs beginning with 'il-'will not work.

2. *Download WebPages*: The website informed us that a number of proxy servers are linked up with the Wireless Leiden network, which enable people to load pages from Internet. In order to make use of these proxy servers, people need to configure the address of the proxy server in their web browser. Therefore the following steps have been followed:
   a. Tools ->Options->Network->Settings
   b. Manual Proxy configuration:
      i. HTTP: proxy: proxy.wleiden.net PORT: 3128

3. Although Wireless Leiden is talking to several Internet Service Providers about offering regular Internet subscriptions over the Wireless Leiden network at this moment there is no official possibility to gain access to Internet via the network of Wireless Leiden. *People are limited just to load web pages*. One of the most important reasons for this is the fact that service requires support which demands much more time than can be handled by their volunteers[4].

What is an SSID and ESSID

In Wi-FiWireless LAN computer networking, a **service set identifier** (**SSID**) is a code attached to all packets on a wireless network to identify each packet as part of that network. The code is a case sensitive text string which consists of a maximum of 32 alphanumeric characters. All wireless devices attempting to communicate with each other must share the same SSID. Apart from identifying each packet, SSID also serves to uniquely identify a group of wireless network devices used in a given "Service Set".[5]

There are two major variants of the SSID.

- Ad-hoc wireless networks (IBSS) that consist of client machines without an access point use the **IBSS ID** (Independent Basic Service Set Identifier)

- Infrastructure networks which include an access point (BSS or possibly an ESS) use the **BSS ID** or **ESS ID** (E for Extended) instead.

Measurements
We took into consideration the places that our survey's users specified as places that they would prefer to have internet access. Thus, several *hotels*, *cafeterias-restaurants*, *libraries* and *places within the vicinity of the universities* or public spaces like *parks*, *shopping malls-supermarkets*, the *train and bus station* and the *hospital* were tested.

At every place that a test was performed the following measurements were done:
- *Signal strength*: Windows XP uses five bars to indicate the strength of the signal
  - one bar indicates very low strength and 5 bars an excellent one

- Using the website:
  http://www.speedtest.nl/TestSuite/TestController.asp the following were measured:
    - Download Speed
    - Connections per minute
- Finally the author evaluated the browsing experience
    - From very low to Excellent

My house
For curiosity reasons and since the flat I currently live is located at the centre of Leiden (Korevaarstraat 6c 3rd floor Attic) a test was performed.

ESSID in range:
- *ap-zw.cetim1.wleiden.net*
- signal strength: 3 bars
- Download speed:75.4 Kb/sec (603Kbps)
- Connections per minute: 52.0
- Browsing experience: good

Hoogvliet-supermarket (20 meters from my house)

- *ap-zw.cetim1.wleiden.net*
- signal strength: 4 bars
- Download speed: 250.4 Kb/sec (2003Kbps)
- Connections per minute: 194
- Browsing experience: very good

Very interesting and maybe surprising is that the same test was performed 2 meters away inside a bus stop and no connection was even available.

Van de Werf - Park (opposite of the Leiden's University Law faculty)

Two tests were performed:
1. First bench in the beginning of the park.
   - *ap-zo.stadhuis1.wleiden1.net*
     - signal strength: 2 bars
     - Despite the signal connection could no be established

2. Cafeteria in the other end of the park
   - *ap-omni.imi.wleiden.net*
     Signal strength: 2 bars no connection could no be established

Law faculty -Library

Two tests were performed one outside of the building and one inside the library. In both occasions no SSID was in range and thus there was no possibility to use the internet.

Public area-park in Boisotkade

The test was performed on the bench after the bridge and the following SSID was found:
- *ap-omni.imi.wleiden.net*
- signal strength: 3 bars
- despite the signal connection could no be established

Cafeteria in the junction of Kaiserstraat and Boisotkade

- *ap-omni.imi.wleiden.net*
  - signal strength: 3 bars
  - despite the signal connection could no be established

Plexus-Library –Leiden University

Outside: Two ESSIDs in range
- *ap-omni.imi.wleiden.net*
  - signal strength: 3 bars
  - despite the signal connection could no be established

- *ap-omni.huub.wleiden.net*
  - signal strength: 3 bars
  - browsing experience was so low that didn't allow us to perform the download speed test

Inside the library:
There was no ESSID in range

Lipsius-Leiden University

Two tests were performed, one outside and one in the restaurant room which is used as a study room as well, but in both occasions no SSID was found in range

Main Library-Leiden University

Two tests were performed, one outside and one in the restaurant room which is used as a study room as well, but in both occasions no SSID was found in range

Restaurants – Cafeterias in the center of the city

- Hong Kong in Pieterskerkhof
- Restaurant in den BierBengel

Both restaurant lie at the heart of Leiden and although many 'il' ESSIDs were in range no proper ESSID could be found.

- Restaurant FoodXL in Maarsmansteeg

This one has in addition one appropriate ESSID: *ap-zw.staadhuis1.wleiden* with signal strength of 2 bars but no connection could be established.

- Bagels and Beans
  o *ap-no.cetim1.wleiden.net*
    - signal strength:2 bars
    - no connection could be established

- V&D – La Place restaurant
  o No ESSID could be found in range

- Café Van Engelen – terrace
  o *ap-centrum.wleiden.net*
    - signal strength: 3 bars
    - no connection could be established
  o *ap-no.cetim1.wleiden.net*
    - signal strength: 2 bars
    - no connection could be established

- Restaurant-Café Dende-terrace
  o *ap.centrum.wleiden.net*
    - signal strength: 3 bars
    - very low browsing speed and unstable connection that didn't allow a download speed test

- Restaurant Stadhouder-terrace
  o *ap-no.cetim1.wleiden.net*
    - signal strength: 3bars
    - slow browsing speed –unstable connection- no download speed test possible

- Restaurant –Café Einstein- terrace
  o *ap-no.cetim1.wleiden.net*
    - signal strength: 3bars
    - slow browsing speed –unstable connection- no download speed test possible

- CITY HALL- terrace
  o *ap.no.cetim1.wleiden.net*
    - signal strength: 5 bars
    - download speed: 197.2 Kbytes/sec (1578Kbps)
    - connections per minute: 224.0
    - very good browsing speed

- Restaurant –Vooraf en Toe
  o *ap.no.cetim1.wleiden.net*
    - signal strength: 3 bars
    - download speed: 21.2 Kbytes/sec (170Kbps)
    - connections per minute: 16.0
    - slow browsing speed

- Restaurant De burcht
  o *ap-no.cetim1.wleiden.net*
    - signal strength :2 bars
    - download speed: 18.2 Kbytes/sec (146kbps)
    - very slow browsing speed
  o *ap-café.oblc.wleiden.net*
    - signal strength: 2bars
    - no connections could be established

The following three ESSIDS all had excellent or very good signal but no connection could be established probably because of proxy reasons. A hypothesis could be that a different proxy is required and the wireless Leiden foundation will be approached. However, there is no time for this research to come with different results.
    - *ap-achter.oblc.wleiden.net*
    - *ap-krug.burcht.wleiden.net*
    - *ap-studie.oblc.wleiden.net*
- McDonalds-square
  o *omni.cope0.wleiden.net*
    - signal strength: 4 bars
    - download speed: 30.5 Kbytes/sec (244 Kbps)
    - slow to good browsing speed

- De water lign (prinessekade)
  o omni.lvlno.wleiden.net
    - signal strength: 4 bars
    - no connection could be established

- English Pubs North End (Rapenburg)
  - *omni.cope0.wleiden.net*
    - signal strength: 4 bars
    - download speed: 41Kbytes/sec (328 kbps)
    - connections per minute: 246
    - browsing speed: good

- Café-Restaurant Barrera (Rapenburg)
  - *ap-omni.huub.wleiden.net*
    - signal strength: 3 bars
    - download speed: 25.4 Kbytes/sec (200 Kbps)
    - connections per minute: 315
    - browsing speed: slow

HOTELS

- Hotel De Doelen (Rapenburg)
  - *omni.cobo.wleiden.net*
    - signal strength: 4 bars
    - download speed: 31Kbytes/sec (248 kbps)
    - connections per minute: 199
    - browsing speed: slow

- Hotel Nieuw Minerva
  - ap-binnen.centrum.wleiden.net
    - signal strength: 5 bars
    - download speed: 52.2 Kbytes/sec (418kbps)
    - browsing speed : good to slow

- Hotel MayFlowers
  - No ESSID in range

- Hotel Da Vinchi
  - No ESSID in range

Bus Station Leiden
There was not even one ESSID in range

Train Station Leiden

- La Place Restaurant
  - ap.omni.lebkov.wleiden.net
    - signal strength: 3 bars
    - no connection could be established

- Platform 2
  - ap.omni.lebkov.wleiden.net
    - signal strength: 3 bars
    - no connection could be established

- Platform 4
  - omni.rabo.wleiden.net
    - signal strength: 3 bars
    - no connection

- Platform 5
  - ap-omni.lebkov.wleiden.net
    - signal strength: 5 bars
    - no connection could be established, possibly because of different required proxy settings
  - omni.rabo.wleiden.net
    - signal strength: 5 bars
    - Despite the excellent signal strength the browsing speed was very low and the download speed test could not be performed

TAXI STATION (behind the train station)

  - ap-omni.lebkov.wleiden.net
    - signal strength: 5 bars
    - no connection could be established, possibly because of different required proxy settings

HOSPITAL

  - ap-omni.lebkov.wleiden.net
    - signal strength: 5 bars
    - no connection could be established, possibly because of different required proxy settings

Ranking of Leiden

Under our strategy and methods title we had specified that the more the current wireless city characteristics will be similar to the characteristics that the citizens have specified the higher the ranking of the city will be. If no similar characteristic is found the ranking of the city will be zero.

However, the results of our tests do not allow for such a complex ranking algorithm that

takes into account all the characteristics that users specified. Thus, for this research, the emergence of the ranking of the city of Leiden will be based in a very simplistic algorithm.

The places that tested will be given ranks of either zero (0), in the case that NO browsing is possible, or (10) if browsing is possible even if it is very slow.

Rankings per category

Hotels

Four hotels in the center of Leiden were tested. In two of them browsing was possible whilst in the other no connection could be established.

Ranking algorithm: (0+0+10+10)/4
Ranking: 5

Cafeterias-Restaurants

Seventeen (17) Cafeteria-Restaurants were tested from which in nine (9) browsing was possible whilst in eight (8) it was not.

Ranking algorithm: (8x0 + 9x10)/17
Ranking: 5.3

Train- Bus –Taxi station

In the train station all platforms were tested and in none of them, browsing was possible. In different places of the bus station browsing was not possible. In the taxi station behind the train station, no browsing was possible

Ranking: 0

Libraries-university areas
Four (4) places were tested from which only in one browsing was possible

Ranking 2.5

Parks-public spaces

Three 3 places were tested and only in one browsing was possible

Ranking 3.3

Accumulated results and total ranking

In total (4+17+3+4+3) 31 places were tested. In 13 of them browsing was possible whilst in the other 17 it was not.

Ranking algorithm: (13x10 + 17x0)/31

Total Ranking of the city of Leiden: 4.2

Conclusion
By analyzing extensively the results of the questionnaire, the identification of what the users want when they use the city's wireless network has been specified. In addition, the wireless capability of the city of Leiden was tested at the places that the users specified and as a result the city was ranked using a simplistic algorithm. However, this algorithm by no means can provide a real framework for ranking wireless cities since it is very simplistic and lacks the evaluation of very important characteristics like the one of data transmissions security, the multiplicity of tasks performed while connected like for instance email or voice over IP (Skype) and network stability.

Acknowledgments

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In addition we would like to gratefully acknowledge the help of Maria Groutidou for her assistance while we were testing in the city of Leiden. Her help in making notes and holding the umbrella is deeply appreciated.

APPENDIX

Results of Main Questionnaire

The following questionnaire was conducted as part of two studies regarding the rankings of wireless cities and some of the questions might not be directly related to this study. Two hundred and twelve (212) people took part in this survey representing more than 23 countries. The questions of interest and the facts that they revealed are the following:

Question 5 shows that the majority of the subjects either currently own a handheld device that supports wireless networking or are planning to buy one in the immediate future.

Question 6 elicits the important places that people want to have internet access using a wireless network

Question 7 indicates that users would most probably like to have wireless access to a wireless network while traveling through the city by using a car or public transportation.

Question 8 shows that users are currently using a wireless network in fewer places that they would like, as indicated in question 6. The places missing are Public Areas (Park, etc) and Public Transportation (Bus, Metro and Train)

Question 9 reveals that the cost factor is an important issue for wireless networking as
the majority of users are either skeptical of paying for wireless access or not willing to.

Question 10 indicates the need for VoIP support from the wireless service providers as an important criterion.

Questions 11, 12 and 13, show that users are aware of possible security issues concerning wireless networks and are not willing to use on-line transactions, such as ordering and payments, through a wireless network. This confirms that security is a major concern in the minds of users.

Question 14 shows that the majority of users would use a wireless network in order to check their mail and as the majority of them use mail clients, the necessity for networks to support POP3, IMAP and other similar mail client technologies becomes very important.

Questions 15 and 16 indicate the importance of service availability from the part of the wireless service provider.

Finally, question 17 shows the importance of the network's performance in terms of bandwidth.

Results

No of records in this query: 212
Total records in survey: 212
Percentage of total: 100.00%
01/06 – 11/06/2007

SQL: SELECT count(*) FROM survey_3

Field Summary for 01:

Please indicate your age:

Answer	Count	Percentage
No answer	0	0.00%
18-25 (1)	106	50.00%
26-39 (2)	78	36.79%
>40 (3)	28	13.21%

Field Summary for 02:

Please indicate your gender:

Answer	Count	Percentage
No answer	0	0.00%
Female (1)	97	45.75%
Male (2)	115	54.25%

Field Summary for 03:

Please indicate your profession:

Answer	Count	Percentage
No answer	2	0.94%
Student (1)	97	45.75%
Employed for less than 10 years (2)	62	29.25%
Employed for more than 10 years (3)	36	16.98%
In retirement (5)	9	4.25%
Currently unemployed (4)	6	2.83%

Field Summary for 04:

Please indicate where do you currently live?

Answer	Count	Percentage
Answer [Browse]	205	96.70%
No answer	7	3.30%

Field Summary for 05:

Do you have/own a laptop or any other handheld device that supports Wireless networking?

Answer	Count	Percentage
No answer	2	0.94%
Yes (1)	157	74.06%
No (2)	34	16.04%
I am planning to purchase one in the near future (3)	19	8.96%

Field Summary for 06:

Considering the fact that Internet access would be available in any of the following places (outside your home and office), in which places would you use it? (Please indicate the 3 most important places or define your own in the box below)

Answer	Count	Percentage
Hotel (1)	110	51.89%
Cafeteria (2)	71	33.49%
Restaurant (3)	19	8.96%
Airport (4)	106	50.00%
Taxi ride (7)	20	9.43%
Hairdresser (8)	4	1.89%
Hospital (9)	30	14.15%
Banks (10)	13	6.13%
Library (15)	98	46.23%
Public Transportation (Bus, Metro, Train) (6)	74	34.91%
Beach (11)	18	8.49%
Public Areas (Park, etc) (5)	65	30.66%
Public Areas within the vicinity of Universities (16)	54	25.47%
Store or Shopping mall (12)	20	9.43%
Stadium (13)	3	1.42%
Harbour (14)	6	2.83%
I use the Internet only at home and/or office (17)	25	11.79%
Other Browse	6	2.83%

Field Summary for 07:

Would it be useful for you to have wireless access while traveling through the city using a car or public transportation?

Answer	Count	Percentage
No answer	4	1.89%
Yes (1)	118	55.66%
No (2)	28	13.21%
Perhaps (3)	62	29.25%

Field Summary for 08:

When not at home, or your office, where do you currently use the Internet? (Please indicate the 3 most important places or define your own in the box below)

Answer	Count	Percentage
Hotel (1)	83	39.15%
Cafeteria (2)	44	20.75%
Restaurant (3)	8	3.77%
Airport (4)	62	29.25%
Public Transportation (Bus, Metro, Train) (5)	18	8.49%
Taxi ride (6)	1	0.47%
Hospital (7)	2	0.94%
Banks (8)	8	3.77%
Hairdresser (9)	0	0.00%
Library (10)	81	38.21%
Beach (11)	2	0.94%
Public Areas within the vicinity of Universities (12)	50	23.58%
Stadium (14)	0	0.00%
Store or Shopping mall (15)	12	5.66%
Public Areas (Park, etc) (16)	9	4.25%
Harbour (13)	4	1.89%
I use the Internet only at home and/or office (17)	50	23.58%
Other [Browse]	13	6.13%

Field Summary for 09:

In case you would like to use a wireless network, are you willing to pay for it?

Answer	Count	Percentage
No answer	2	0.94%
Yes (1)	63	29.72%
No (2)	59	27.83%
Maybe (3)	88	41.51%

Field Summary for 10:

Would you use VOIP (voice over IP) videoconferencing services like Skype when located outside your home or working environment?

Answer	Count	Percentage
No answer	9	4.25%
Very often (1)	46	21.70%
Some times (2)	108	50.94%
Never (3)	49	23.11%

Field Summary for 11:

Are you aware that security in open wireless networks might be lower than in fixed line networks?

Answer	Count	Percentage
No answer	7	3.30%
Yes (1)	160	75.47%
No (2)	45	21.23%

Field Summary for 12:

Considering the fact that you might be more vulnerable by using unsecure wireless networks are you willing to make on-line transactions such as ordering and payments through a wireless network?

Answer	Count	Percentage
No answer	13	6.13%
Yes (1)	63	29.72%
No (2)	136	64.15%

Field Summary for 13:

How important is security when using the internet outside your home or working environment?

Answer	Count	Percentage
No answer	7	3.30%
Very important (1)	107	50.47%
Important (2)	88	41.51%
Not important (3)	10	4.72%

Field Summary for 14:

If you decide to use a public wireless network what would you use it for? (Please indicate the 2 most important choices)

Answer	Count	Percentage
Browsing the internet (1)	152	71.70%
Checking the mail (2)	179	84.43%
Make an online order or payment (3)	21	9.91%
Use messaging services (MSN, Yahoo messenger etc.) (4)	66	31.13%
Use VoIP/Videoconferencing services (Skype etc.) (5)	40	18.87%
Other [Browse]	5	2.36%

Field Summary for 15:

Consider the fact that you want to connect to a wireless network and you cannot succeed even after trying many times, would you try to connect again after a while or not?

Answer	Count	Percentage
No answer	6	2.83%
Always (1)	23	10.85%
Usually Yes (2)	113	53.30%
Usually No (3)	67	31.60%
Never (4)	3	1.42%

Field Summary for 16:

If you get informed that you cannot connect at that specific place will you consider going somewhere else to achieve a better network coverage?

Answer	Count	Percentage
No answer	10	4.72%
Always (1)	7	3.30%
Usually Yes (2)	131	61.79%
Usually No (3)	57	26.89%
Never (4)	7	3.30%

Field Summary for 17:

Suppose that you are connected to a wireless network and want to browse the Internet or check your email; would a high browsing speed be a considerable advantage for you?

Answer	Count	Percentage
No answer	0	0.00%
Yes, very important (1)	102	48.11%
Yes (2)	102	48.11%
No (3)	8	3.77%

The results of this Questionnaire as well as the IP addresses of the participants are available in SQL format for any further reference.

References:

[1] Paul Nguyen, How Wireless is Leiden, June 2006

[2] Richard Velden, Methodic Measurements for 802.11b Wireless Networks: Wireless Leiden, 2005

[3] Wireless Leiden Foundation, http://www.wirelessleiden.nl/english/

[4] Wireless Leiden Foundation, http://www.wirelessleiden.nl/english/howtoconnect.shtml

[5] http://www.answers.com/ESSID