A study conducted on internet coverage in rural areas using broadband technology

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Abstract:

The development of information technology is a process which takes place with a breathtaking speed , so an emerging country like Kosovo, should be prepared for this challenge. The most important sector of information technology is broadband, otherwise as known for the public three in one i.e. in an equipment three services are spread (TV, sound and broadband Internet) , from which Kosovo's future economic development should be focused. This is especially true for rural areas which are most likely to benefit from this technology. Broadband technology is a term, which defines multiple methods of information distribution through internet at great speed. Concerning the broadband, it should be analyzed which technology should be used for its distribution, so the businesses that use it, don't have any obstacles. Therefore, for many reasons, it is estimated that broadband (which had an optic fiber as transmitter), is optimal from the perspective of efficiency in transmission, and price. Some of the broadband technologies are: optic fiber, coaxial cable, DSL, Wireless, mobile broadband, and satellite connection. The ultimate goal of any broadband service provider is being able to provide voice, data and the video through a single network, called triple play service. The future of world economy is strongly connected with broadband technology.

Key words: Internet, broadband, technology, e-business.

Introduction

The internet is a connection of millions of networks connected among them, thus creating a global network communication. So, the internet is the network of networks. This network is a distributed system and it is not a property of anyone and it is not under anybody's administration. We can say that Internet is a global space that enables information exchange in large quantities within the whole world at great speed [1].

There are a large number of internet services which are constantly increasing. Some of these services are:

- World Wide Web (WWW)
- Electronic mail (E-mail)
- File Transfer Protocol (FTP)
- Information research
- E-commerce, etc.

The internet has dramatically changed the role of technology in business nowadays. The internet has been embraced much faster than previous technologies. While the radio took 38 years for to achieve 50 million users, the personal computer took 16 years, the television took 13 years and the internet took only 4 years [2].

Most people think that the internet, e-businesses and e-commerce are the same thing. The internet is a mean or a tool; e-commerce is simply a transaction (buying or selling) through internet or other electronic devices, while as e-business is the integration of people, processes and technology, in order to make business.

Internet in Kosovo

Information technology in Kosovo has recently recorded a very high and fast development like the internet penetration in homes and offices. This can easily be seen from a survey done by STIKK (Association of Technology of Information and
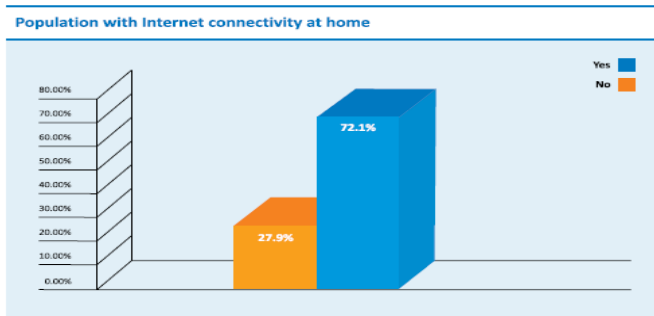
Communication in Kosovo) [3].

Figura 1: Popullsia me Internet të lidhur në shtëpi

This increase is approximately equal in levels with Bulgaria and Greece, and it is attributed to the development of broadband technology in some rural areas of Kosovo, by Kosovar powerful companies such as: Ipko, PTK, Kujtesa, and the small ones working in an informal way.

We should also be satisfied with the answers of the same survey conducted by STIKK regarding the question whether people know about online payments through e-banking. And 3 % of the respondents say that they are not aware of that service. And as far as trusting the internet for payments, 47.6 % of the respondents answered negatively.
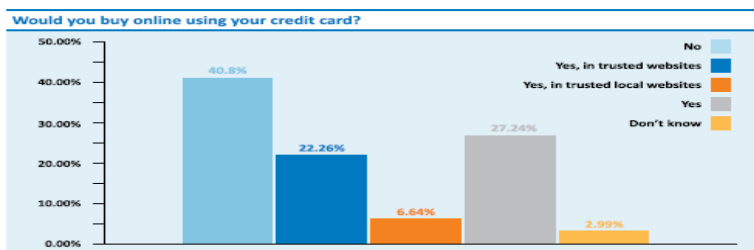

Figura 33: Besueshmëria e blerjeve online

However, although the percentage of those who have heard of online purchases is very high, the use of online shopping is very small and negligible. There are efforts to buy, especially from those in the field of Information and Technology and from those who try it out of curiosity.

We can say that in Kosovo a lot of electronic devices are being bought (which is different form online purchasing), especially though the so called Point of Sales (POS) which is a terminal placed in supermarkets that enables transaction or payment by card under the supervision of the sales person.

To know whether or not kosovars use online purchasing we must know if they possess credit cards. According to analyses and studies conducted by The Central Bank of Kosovo (where the rate of credibility is 90 %), 99.6 % of respondents have a bank account [4].

How many Kosovars have bank accounts?

■ Yes ■ No

99.60%

0.40%
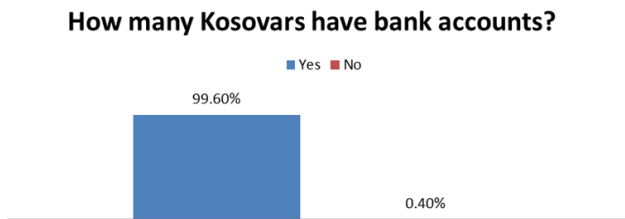
This shows that in Kosovo, the transition from cash in the payment system through banks has already started because the first step towards this is the bank account opening.

To know why there aren't more online purchases through bank accounts, first we must look the monthly income of the people with bank accounts. According to the Central Bank of Kosovo   (which in the future will be called European Central Bank), 37.5% of employed people have a monthly income between 200 to 500 Euros.

Monthly income

37.50%

21.40%

6%

3.80%

0.20%

under 200   200-500   501-700   above 700   No answer
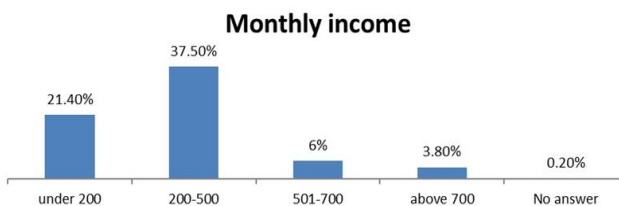
In the question how they use credit cards, the respondents have

given the following answers:

- 22.2 % use their credit cards regularly
- 27.4% use them often
- 41.7 % rarely use them
- 7.8 % don't use their credit cards

Regardless security attacks in e-business; virtual shops (e-shops) have an enormous opportunity to protect their business. In the picture below it is demonstrated a protection against attacks.
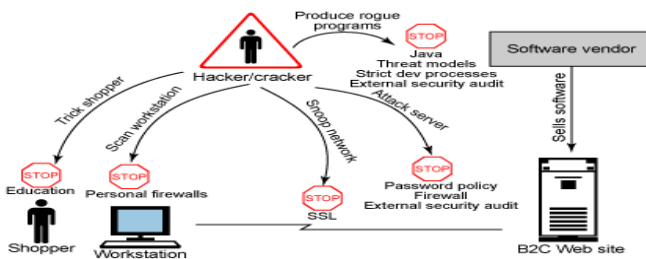
Education is the best way to ensure that your customers take appropriate precautions:

- Install personal firewalls for the client machines.
- Store confidential information in encrypted form.
- Encrypt the stream using the Secure Socket Layer (SSL) protocol to protect information flowing between the client and the e-Commerce Web site.
- Use appropriate password policies, firewalls, and routine external security audits.
- Use threat model analysis, strict development policies, and external security audits to protect ISV software running the Web site.

Broadband technology

The broadband is often called High speed internet, because it usually has high speed of data transmission compared to the

dial-up method through modem (standard telephonic lines). In conclusion, every connection of the client with the speed of 256 kbit/s (0.256 Mbit/s) or more is considered to be Internet broadband [5].Whereas today, broadband connections often mean the speed up to 100 Mbps. There are numerous definitions concerning the term of broadband technology. Here are some of them:

- Internet speed
- Usage of large applications
- CRM system installation (Customer Relationship Management)
- Low prices
- Using one cable instead of some
- Time saver
- Space saver
- The internet is always connected
- 24 hour surveillance of corporations and shops through cameras with real IP or different programs (Log Mein, Team Viewer etc.)
- Instant messages
- Online selling and buying
- Private network installation (VPN-virtual private network)
- Permanent online connection with clients, suppliers, investors, tax authorities and all of them who have interest in this company.

Optic fibers

Technologies based on the optic fiber are new technologies which convert data to light impulses and send them on line. Then, at the destination happens the reverse process, the impulse is converted in data (notes and information). Because of the small loss on lines and because the data transmission can be done via light impulses, the fiber can be used in great

distances without the need of a repeater (a device used to strengthen the signal). The fiber's bandwidth can be 100 Mbps, 1 Gbps, 10 Gbps, but this is for the accessories that will be put on the line [6]. Actually the bandwidth of the optic fiber as a device is unlimited and this is set by the other functioning devices.

Some of the most famous technologies that use the optic fiber as a device are:

- GEPON (Gigabit Ethernet Passive Optical Network), and
- GPON (Gigabit Passive Optical Network)
- BPON (Broadband Passive Optical Network)

From the abovementioned technologies the newest and the most used one is GPON.

GPON is a new technology with the biggest rate of spread [7] and that is used to approach the simultaneous usage of fibers with greater bandwidth. New services such as: VoD (video on demand -sending a movie, a TV program when the client requests it), IPTV, HDTV, 3D TV, conference videos with a lot of participants, telemedicine and other applications that require a higher capacity to fulfill demands on the transmission speed. This technology (GPON) is made of these devices:

- OLT (Optical Line Terminal) of GPON which usually is put in company's headquarters and enables service provision to last users
- Optic cable wires
- Optical splitters which is usually put somewhere in the middle of the company offices and the client
- ONT (Optical Network Terminal) of GPON that has to be placed in the house of the buyer [8].

In this technology the bandwidth for downstream is up to 2.5 Gbps, and for upstream is up to 1.25 Gbps. We can say that PON and GPON technology are based in three networks topology: FTTH, FTTB and FTTC, which have the following meanings:

- FFTH (Fiber to the home)- the connection of optic fiber to houses
- FTTB (Fiber to the building) –the connection of optic fiber to the buildings
- FTTC (fiber to the curb) - the connection of optic fiber to a side curb or road. It has another name (FTTN-fiber to the node).

Devices we need to implement this technology are:

- OLT motherboard to install the GPON with port boards (optional)
- OLT device with 8 gates, 1 gate has 64 clients
- Splice device, to put the fibers together
- Area distribution box
- Building distribution box
- ONT device that is put to the client
- IPTV setup box
- Optic passive splitters with separated reports: 1:4, 1:8, 1:16, 1:31, 1:64 etc. [9].

The question is how many of these devices do we need? First we have to calculate how many clients we want to supply from a single OLT (how many houses we want to supply with an OLT). The maximum numbers that we can supply from an OLT is exactly 512 (8 gates* 64 splitter separations = 512)

Prices of the abovementioned devices (hardware devices) should be summed up with other costs so we can see a full list of money spending:

- The pipeline for the deployment of fiber from the central office to optical splitter
- The pipeline of fiber placement from the splitter to the residence
- The work of IT technician for the connection of devices and fiber on the network. An IT usually has to work 4 hours in a residence and besides the work they have other connecting equipment they need to use
- The price of the fiber for a house only is insignificant but

if the habitat has more houses then it costs more [10]

- The price of the channel's opening for placing fiber pipes
- The price of pits opening to attach and adjust the bond between the fibers (splice)

If these spending are turned to real prices, then we can say that a meter cable of optic fiber with 12 wires costs 0.55 € a meter, the pipeline where the optic fiber is put costs 3 € for one meter length, so it means that one meter length costs almost 5 € (because it might be broken several times and we will have to fix it). This price is only for urban places and in the cases where a new canal opening is needed, the price for meter length will be more expensive, depending on the location. For the transport of this technology to rural places the full price for a meter length is almost 10 euro's, because we have to calculate the opening and establishment of manholes.

Knowing the prices of the equipment we have to use, then we can calculate how much the investment will cost through GPON technology in the village of Bishtazhin, approximately 10 km out of the city, which has 200 clients.

The parameters we have to estimate are:

- OTL Device (starting point in the base) 1 piece * 10.000 € = 10.000 €
- Open channel   10.000 m * 10 € = 100.000 €
- Splitter 1:64   3 pieces * 200 € = 600 €
- Splitter 1:8   1 piece * 30 € = 30€
- ONT device   200 pieces * 120 € = 24.000 €
- IPTV Setup box   200 pieces * 120 € = 24.000 €

(10.000 € + 100.000 € + 600 € + 30 € + 24.000 € + 24.000 €)/200 house = 158.630 €/200 = 793 €

According to the upper data, we can see that the proximate total investment sum is 158.630 €. If this amount gets divided by the total number of clients (200 altogether), then the total cost for a house is 158.630 € / 200 clients = 793 €. So, this is the approximate cost of investment in this project.

As we said, the price above is calculated through fiber installation in underground channels. There is a chance for the installation to be made through air infrastructure i.e. telephone lines. The costing price in this case must be cheaper. In the air

infrastructure, we should take into consideration the telephone lines' placement to put the fiber in and the connecting enclosures. The telephone lines must be established in a distance of 40 meters from each other, therefore for a distance of 10 kilometers we need 250 telephone lines. The calculations now are:

- OLT device (the basic starting point)- 1 piece * 10.000 € = 10.000 €
- Telephone lines   - 250 pieces * 100 € = 25.000 €
- Splitter 1:64   - 3 pieces * 200 € = 600 €
- Splitter 1:8   - 1 piece * 30 € = 30 €
- ONT Device   - 200 pieces * 120 € = 24.000 €
- IPTV Setup box   - 200 pieces * 120 € = 24.000 €

In this version, the approximate cost of investment for client is:

(10.000 € + 25.000 € + 600 € + 30 € + 24.000 € + 24.000 €) / 200 client=83.630 € / 200 = 418 €

Let's take the example, e.g. if we have a wider area with 5000 houses (5000 subscribers). In this case, surely the company investment would increase because they would have to subsidize more additional equipment. The calculations of what we need are as follows:

- For 5000 clients we need 10 OLT devices with 8 gates, because such a device can connect maximum 512 clients, i.e. 10* 512 = 5120. Because we need to buy 10 devices like that, the price might be cheaper than the one calculated above.

  10 pieces * 8.000 € = 80.000 €

- If we have 5000 clients (subscribers) we need to put the optic fiber in the house of everyone, and knowing that in rural areas the houses are away from each other, then the price for open channels is calculated as follows:

  30.000 m * 9 € = 27.000 €

- Because we have 10 OLT devices, each one with 8 gates, then we have to calculate how many 1:64 splitters we need:

  10 OLT * 8 gates = 80 gates

  1 gate = Splitter 1:64 = 64 clients

  80 gates (80 splitters) * 64 clients = 5120 clients

80 splitters * 150 € = 12.000 €
- ONT device
  5000 pieces * 100 € = 500.000 €
- IPTV Setup box
  5000 pieces * 100 € = 500.000 €

(80.000 € + 27.000 € + 12.000 € + 500.000 € + 500.000 €) / 5000 houses =
1.119.000 € / 5000 = 224 € / clients

So, as we can see, with the increase of subscribers the investment also increases, but the cost decreases, because we can use all the devices and the price of the devices keeps decreasing.

Dsl technology (Digital Subscriber Line)

Logging on into internet can be done through regular modem, through local network office, through cable modem [11], or through DSL. DSL technology (digital subscriber line) offers network connection by transmitting data through existing telephone lines copper cables. I.e. the DSL service can be distributed in the same time with telephonic service in the same telephonic line [12].

Most of the businesses are connected to asymmetric DSL lines (ADSL). Because most of internet users use it to collect data rather than giving data, then ADSL separates the line frequencies in the way that the speed from the internet to the user is a few times greater than the opposite. Downstream rate of data receiving is 1.5 to 9 Mbps (consummator direction), whereas the upstream rate is smallest and is up to 640 kbps (provider direction).This is only for asymmetric DSL technology (ADSL). In Symmetric Digital Subscriber Lines, downstream and upstream rates are equal.

DSL technology is made of these components:
- Customer Premise Equipment (CPE)
- The device that is placed in the central office (CO)
- Network (extension cable) between these two important equipment (this wire can be made out of copper strands,

which in this case can affect the quality of transmission and the optical fiber where distance is not a factor of influence).

Customer Premise Equipment (CPE)

On the signal receiver (transceiver), the client requires the following equipment.

- IPTV Setup Box over DSL
- DSL Splitter-i (coaxial cable splitter on TV and internet)
- DSL (VDSL2) Modem, and
- Landline phone

The prices of the devices shown above can be: IPTV Setup Bow through which we get the TV signal costs approximately 100 €, DSL Splitter costs 5 €, landline phone costs 5 to 10 € and the DSL Modem costs approximately 100 €. All of these are placed into the house or office of the client and the sum needed to complete it all is:

$$100 € + 5 € + 100 € + 5 € = 210 €$$

The device placed in the central office (CO)

DSLAM (Digital Subscriber Line Access Multiplexer is the device placed into the central office (CO) or better in the side of the provider and that is the device that enables DSL. The connections from a lot of clients are put together in a single connection with a bigger internet capacity by DSLAM. DSALM devices are very flexible and support different types of DSL in an office and different inflections within a single DSL.

DSLAM offers a major distinction in service between ADSL and cable modem. The distinction is that at the cable modem every new subscriber reduces the network's performance. This does not happen at ADSL because this offers a dedicated connection (the new subscriber does not reduce the network performance). One of its types is MA5600, which supports multiple technologies such as: VDSL2,

ADSL/ADSL2/ADSL2+, etc. It is also a choice for *triple play*.

This device can provide a 30 Mbps bandwidth for every subscriber and it can support up to 896 subscribers [13].

The price of this device is approximately 1000 €, and this price is taken from a message exchange between manufacturers or companies with electronic stores (B2B- for instance alibaba.com) of such equipment. There are more devices like this, with fewer gates.

Calculating the investment

The equipment's we need to complete this technology are:
- DSLAM
- IPTV Setup Box over DSL
- DSL (VDSL2) Modem
- DSL Splitter
- Telephone line
- Coaxial Cable

Whereas the parameters are calculated as follows (for 200 houses and businesses in the village)
- DSLAM   - 1piece * 1000 € = 1.000 €
- IPTV Setup Box over DSL   - 200 pieces * 100 € = 20.000 €
- DSL (VDSL2) Modem   - 200 pieces * 100 € = 20.000 €
- DSL Splitter   - 200 pieces * 5 € = 1.000 €
- Open Channel   - 10.000 m * 9 € = 90.000 €

And, the price for a client in Bishtazhin village which has 200 clients is as follows:

(1.000 € + 20.000 € + 20.000 € + 1.000 € + 90.000 €) / 200 client = 132.000 € / 200 = 660 €

For example, if we had a wider area of 5000 houses (5000 subscribers); the investment of the company would be bigger because they would need to subsidize extra devices. The math's of what it would cost is as follows:
- Usually, one DSLAM device supplies 896 clients, then for 5000 clients we need 6 of those, because :

6 pieces * 896 clients = 5376 clients

Whereas their price would be,

$$6 \text{ pieces} * 1000 \text{ €} = 6.000 \text{ €}$$

- IPTV Setup Box over DSL devices now will be in greater quantity, therefore their price now will be smaller:

$$5000 \text{ pieces} * 90 \text{ €} = 450.000 \text{ €}$$

- What we said above is the same for DSL (VDSL2) modems

$$5000 \text{ pieces} * 90 \text{ €} = 450.000 \text{ €}$$

- DSL Splitters

$$5000 \text{ pieces} * 4 \text{ €} = 20.000 \text{ €}$$

- We already mentioned in the fiber case, that to have 5000 clients, then the network should be distributed in more rural areas and the channels must be taken to each house with large distances in between.

$$30.000 \text{ m} * 9 \text{ €} = 27.000 \text{ €}$$

The costing price for a client in some rural areas, where the subscriber's number might be approximately 5000 is:

$$(6.000 + 450.000 \text{ €} + 450.000 \text{ €} + 20.000 \text{ €} + 27.000 \text{ €}) / 5000 = 953.000 \text{ €} / 5000 = 191 \text{ €}$$

For the activity of a company, is important to store somewhere all of its business activities and transactions. That place where activities and data should be stored is called the database. Another "language" for creating databases is also the, which is based as e in mathematical theories and consists of such elements as: insert, update, delete, query, etc [14].

To create a database one can also use the application program package Office, Access which is a program for managing information from a simple address list up to a complex inventory management [15]. Access can be used in all private firms, in educational institutions, health institutions, in administrative offices , in post offices, banks, tax offices, register offices, in goods' storages, in trading, craft firms etc.

The database is organized in a way that all calculations done manually from previous chapter, now can be calculated automatically through it. Just like any other project, ours that has to do with the extension of broadband technology in rural

area, should have the time to calculate the return on investment by months but by percentage. To calculate the return on investments one should build financial statements. Their construction will be done through accounting rules, through tables and through the database, automatically.

Organizing the data in the database

Our database is constructed as you can see below.

Figure: Created database
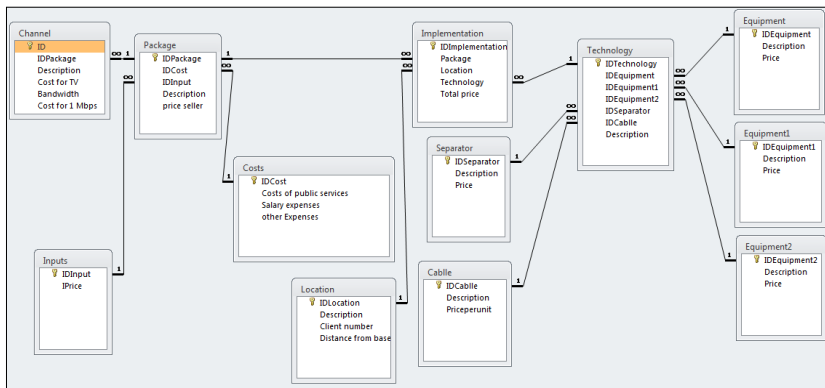
Source: Author's own calculations

Our database consists of twelve entities (which you can see from the picture above, and where are also given each of their fields).
Entities are as it follows:

- Channel
- Other inputs
- Package
- Costs
- Location
- Implementation
- Separator
- Cable

- Technology
- Equipment
- Equipment1
- Equipment2

Entities are a group of events, people, places, or other things that are used to show how data is stored [16].

Attributes of entities are:

i. Channel (ID, Description, Cost per TV, Bandwidth, Cost per 1 Mbps)
ii. Other inputs (IDInput, Input price)
iii. Package (IDPackage, Description, Price seller)
iv. Costs (IDCost, Cost of public services, Salary expenses, Other expenses)
v. Location (IDLocation, Description, Client number, Distance from base)
vi. Implementation (IDImplementation, Package, Location, Technology, Total price)
vii. Separator (IDSeparator, Description, Price)
viii. Cable (IDCable, Description, Priceperunit)
ix. Technology (IDTechnology, Description)
x. Equipment (IDEquipment, Description, Price)
xi. Equipment 1 (IDEquipment1, Description, Price)
xii. Equipment 2 (IDEquipment2, Description, Price)

Attributes are the characteristics of one entity.

The main keys are:

i. ID
ii. IDInput
iii. IDPackage
iv. IDCost
v. IDLocation
vi. IDImplementation
vii. IDSeparator
viii. IDCable

  ix. IDTechnology

  x. IDEquipment

  xi. IDEquipment1

  xii. IDEquipment2

In each new table we create it will be necessary to assign a field as a primary key. Access uses this field to connect the registrations of a table with the records of other tables, and also in the cases when there are thousands of future files in the database and only one is required, the main key speeds up the data finding

1. *Transfer of entities in relations by inserting the secondary keys*

 i. Channel (ID, IDPackage, Description, Cost per TV, Bandwidth, Cost per 1 Mbps)

 ii. Other inputs (IDInput, Input price)

 iii. Package (IDPackage, IDCost, IDInput, Description, Price seller)

 iv. Costs (IDCost, Cost of public services, Salary expenses, Other expenses)

 v. Location (IDLocation, Description, Client number, Distance from base)

 vi. Implementation (IDImplementation, Package, Location, Technology, Total price)

 vii. Separator (IDSeparator, Description, Price)

 viii. Cable (IDCablle, Description, Priceperunit)

 ix. Technology (IDTechnology, IDEquipment, IDEquipment1, IDEquipment2, IDSeparator, IDCable, Description)

 x. Equipment (IDEquipment, Description, Price)

 xi. Equipment1 (IDEquipment1, Description, Price)

 xii. Equipment2 (IDEquipment2, Description, Price)

Secondary keys connect the records (rows) of a table with other table's records.

Conclusion

Investments developed according to a previous plan that studies the market well are welcomed. In places like Kosovo, investments are vital for the population, and this is especially related to the possibility of increasing the revenue of the businesses. Such an investment is the distribution of broadband technology in rural areas so those places can have limitless internet. This would create the opportunity that businesses which are in rural areas sell through the internet and that client can previously see if there are the needed products in those businesses.

Our contribution has been creation of the databases with the technology information and other factor information which have to be considered in such investment like distribution of the Internet in rural zones. Besides calculating the sum of investments, the purpose of creating the database has been the automatic calculation of return on investments, which a potential investor might be more interested in.

The methodology proposed in this article is a practical and efficient approach for a preliminary study of an investment in the Internet distribution in rural zones.

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