

ANALYSIS OF ECONOMIC FEASIBILITY OF VOIP TELEPHONY IN A CONSTRUCTION COMPANY IN LAGES-SC

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ARTICLE INFO

Article History:

Received 17th January, 2019
Received in revised form
26th February, 2019
Accepted 09th March, 2019
Published online 29th April, 2019

Key Words:

VOIP. Telephony. Telecom. Asterisk.

ABSTRACT

This article aims to evaluate the VoIP Telephony focused on the evaluation of its economic feasibility applied in the evaluation of a Construction Company in Lages city. In addition it will be analyzed a conventional carrier. The study had about one-year duration, using the comparative descriptive methods. The results in a satisfactory manner, reducing to 40% of the current cost by integrating VOIP solutions as a low-cost differential and satisfactory quality using all the benefits of an Asterisk server.

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Citation: Mohammed M. Salman and Mohammad Z. Al-Rawas. 2019. "Effect of using constructional waste on strength properties of normal concrete", *International Journal of Development Research*, 09, (04), 26866-26874.

INTRODUCTION

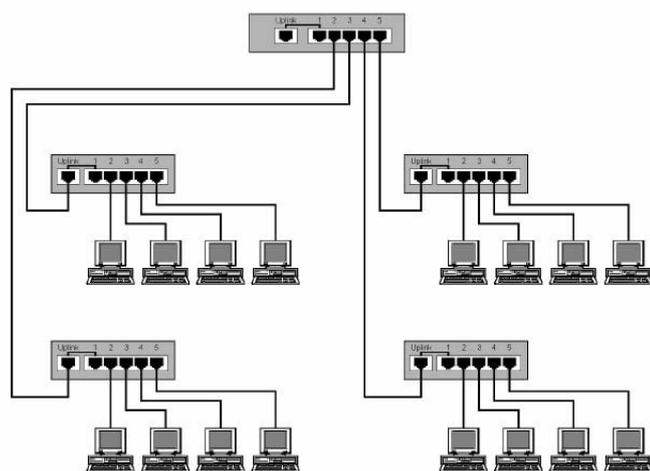
The aim of this study is to modify the existing internet and telephone system into a builder of Lages (SC) with the aim of reducing costs through tools already available on the market. The demand for contact to suppliers and customers makes it necessary to search for plans with lower costs (Rocha Tavares *et al.*, 2018), since the current cost is outdated and too keeps the same value (da Cruz *et al.*, 2018). The purpose of the work is to evaluate the current situations of these services that are offered the construction company in the city of Lages (SC) and use the hardware capabilities and investments available identifying the technical feasibility of equipment in order to maintain the cost initial project as small as possible. To group the services in the same total cost operator tends to be lower, and consequently the cost of maintenance to keep a single infrastructure will be lower, making it the best option financially in the end. Currently the set consists of 2 fixed telephone operators (operator OIS. A. and operator GVT Alive), being employed dedicated lines to the internet plans. The infrastructure of the company is all in metal pair by limiting the use of greater internet speed in downstream and upstream.

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The business plan consists of 10 digital E1 lines, 3 lines grouped together to plan and 3 GSM gateways (cellular interfaces) operating with 1 chip each. The total cost of invoices is higher than expected, having seen the low demand of work of the current moment. The construction company uses an older, the Digistar XT200, which have low maintenance cost, efficiency, and it's all based on analog telephony, highlighting only the E1 channels which is a trunk of up to 30 digital channels. There are two internet plans contracted with operators by the construction company. The operator OI is hired a professional IP link 10Mbps Download and 1 Mbps Upload only, currently used as secondary link *fail-over*, which would make VOIP a low efficiency solution. The plan of the operator GVT Alive by your time has 10% download 50Mbps Upload (5Mbps), making an alternative with greater efficiency, but low effectiveness when considered in the event of internet backups in the cloud storage, what happens in scheduled times and that could interfere with the call quality in moments of early work. There is also the proposal from Algar Telecom, a phone carrier that is initiating the work in town and is present in several States with credibility in trade, offering a better cost-benefit of telephony and internet. The plan drew attention by the cost per minute of LDN (national long distance) and the cost of local calls. The operator also provides improved availability of internet speed operating via optical fiber. You can download up to 200Mbps

provide 40% of upload, i.e. 80Mbps. To solve the cost problem definitively, it will be add a plan of VOIP Telephony (voice over IP) keeping the call quality with a reduced cost that will be up to 50% more in account in relation to the DLD available from carrier Algar. The method used is the comparative descriptive; with a case study of a construction company Lages (SC).According to Gil (2010), the descriptive method, descriptive research have as objective the description of the characteristics of a population, a phenomenon or an experience. For example, what are the characteristics of a particular group in relation to sex, age, family income, level of education.

Lan: Local Area Network (LAN) is a local network of devices that are interconnected. LAN topologies can be different, as well as how to connect hosts. Each topology has its pros and cons according to the limitations. Is economically cheaper for the interconnection between computers and devices. Currently in LAN's most used topology is the topology in tree, where are several stars interlinked, the infrastructure is distributed by structured cabling (vertical and horizontal cabling), which defines basically the amount of Switches is the distance at which the cables have to go before the arrival to the host (limit of 100 m). Figure 1 exemplify a LAN with tree topology.



Source: http://vanderlinde1116217.xpg.uol.com.br/irc_tipos_redes_ip.html

Figure 1. Network LAN with tree topology

PROTOCOLS

TCP: The Transmission Control Protocol (TCP) is one of the protocols under which the Internet is based. This Protocol fragments the input byte stream into messages and passes each one of them to the internet-layer. The destination TCP reassembles incoming messages to the output stream. TCP controls the flow, prevents a transmitter quickly overload a slow receiver with a volume of very large messages (Tanenbaum, 1997, p. 41).

UDP: User Data Protocol (UDP) is a simple transport layer protocol. It is widely used in applications where immediate delivery is more important than the delivery needs, such as the transmission of voice data or video (Righez *et al.*, 2016).

DNS: Domain Name Server, is the Protocol that translates names into numbers, for example when you type www.google.com, the computer will make the referral to the DNS server that will look for an IP address (216.58.222.14 is one of the IP addresses of google) and then view the site

requested. It is possible manually configure a DNS server on the devices, causing these jumps are faster and DNS be resolved instantly (Vinayakumar, Poornachandran, Soman, 2018).

IP ADDRESSING: According to Santos (2009), IP stands for Internet Protocol. The version 4 of this protocol uses a format of address which consists of four octets. Each octet contains 8 bits, which means that the total size of the IP address is 32 bits. Each octet is separated from another by a simple point. An example of IP address is 192.168.0.30. The values that each octet can take are 0 to 255, i.e. a total of 256 values (Santos, 2009, p. 99).

INFRA STRUCTURE: The copper cables suffer from electromagnetic interference and so passing data or voice networks can easily be interfered with by electric power cables, lightning or other cables that distinct signs in different frequencies. Cases of crosstalk, where a pair of cables can be induced to form the famous "cross-line", was solved when using twisted-pair cable and optical fiber, which has immunity to electromagnetic interference solved the problem final.

Coaxial: Coaxial cable consists of a central core which the main conductor is copper, which has generally a more robust insulating between the shielding mesh. This causes the cable shielding mitigate electromagnetic interference, and may send data for greater distances between the ends. Can pass signs for up to 1 km away with a speed of 1 to 2 Gbps, that depends only on the number of hosts which is sectioned (Comer, 2001).

Optical Fiber: This uses the conversion of electrical signals in pulses of light through binary codes (the presence of light represents the bit 1 and the absence of light the bit 0). When injected into the fiber by laser or LED, a light detector at the other end is responsible for identifying this signal and then is converted back into electrical signal. The frequency of this signal can vary and are set up in Windows. This means of transmission, the limit of technology is the fact that the conversion of signals can take a lot more than the passage of light in fiber optics. There are two types of optical fibers: Single mode where the beam of light travels through the fiber core and Multimode, where the light beam travels through the edges in refractory effect (Qian *et al.*, 2018).

IP Telephony: Today it is still widely used in circuit-based telephony all the PSTN (public switched telephone network), where the VOIP (voice over IP is still a paradigm for many mobile operators. Some operators already have the digital system in internal and external workings, as Alive for example. In the VOIP voice encapsulation in IP packets and broadcast usually on the UDP protocol or SIP, should be a real time protocol, is a massive packages or delay can get blinks communication. Much has been improved since the emergence of this technology that brings many benefits to users and customers (Zhu *et al.*, 2019). For Ribeiro, Rodrigues and Marcondes (2001), the main benefits of IP telephony is not dependent on a fixed location to receive the link, i.e. the mobility would be improved so that you can receive the call anywhere via the internet. Another advantage is not having the mandatory use of dedicated devices, for example, you can use the computer to receive and originate calls when you are away from home to receive the fixed link on the mobile internet, among other devices and advantages. It can be used the two technologies of hybrid form, the switched and VOIP through

telephone exchanges PABX (Private Automatic Branch Exchange) or adding a voice Gateway that does the encapsulation of the analog signal in IP packets making it possible to communication.

Internet: The internet began with the ARPANET, a network of American military initiative in the 60 (Tokgöz *et al.*, 2016). It was conceived with the objective of exchanging information between universities and share files in addition to electronic mail (e-mail). Since the beginning of the network was used the TCP/IP suite of protocols, because the machines needed to talk in the same language and what was a network with dozens of computers became a network with thousands of connected computers and devices. The Arpanet became the backbone (spine), where local and regional networks focused on Exchange of information. Mid in 90 years the internet has undergone a major change, and began to use multiple backbones of companies traveling data for large networks and expanding more and more. Today the internet is very popular, being used for entertainment by hundreds of thousands of people all over the world, in different age groups are in contact learning new terms, knowing more content, didactic, or streaming is digital communication (Mendes, 2007).

RESULTS AND DISCUSSION

VOIP Operators: VOIP carriers work digitally, i.e. deliver the solution for the end customer via the internet. May have some forms of delivery of the call, which can be via SIP (Session Initiation Protocol), via TDM (Time-division multiplexing), or via GSM (Global System for Mobile Communications). VOIP Telephony is a low-cost option for proper operation depends on a good internet connection, the better the speed available, better call quality. Currently Call centers use the technology in high-scale by having several advantages over conventional telephony due to the fact that there is no obligation of the recipient of the call back to the number at the time of connection, usually a random number and blocked for incoming calls is a log output only. Another advantage is the fact that there is no limit on concurrent calls, so just need the VOIP account own credits, these Setetel operator offers to purchase and never expire, in addition to allowing branches may register the same account using the benefits without the requirement to be physically in the company (Packer, Reuschel, 2018). Deployment on the building will follow the pattern described, i.e. VOIP calls in Setetel operator will be output only and the number will be random. When using an IPBX (Internet Protocol Branch Exchange), expand the advantages of allowing the creation of digital extensions that can be accessed through dialer software, making it mobile and accessible from anywhere in the world since available internet connection, downloading costs with LDN and mobile.

Cost Analysis: All numbers pertaining to HIS, have a phone Collator and its multiples, where the Collator is the main number to be disclosed and the grouped are additional lines follow the internet subscription for example. In terms of long distance calls (LDN), the speed vary by region and type of recipient. There are some types of speed to fixed, normal and differentiated. For mobile sorting is VC1 VC2 VC3, and. In VC1 is when the area code between source and target match, i.e. are equal. The VC2 is when only the first digit of the area code are the same, for example, codes like 47, 48, are VC2, because only the first digit is equal. On the VC3, the digits of

the area code are different, 41 and 51 are examples. It becomes the most expensive pricing. In the analysis of the results in relation to the DDR franchise LDN 1000 min, shown in Table 1, in December 2016 were consumed 744.7 min in January 2017 were 757.2 min and in Feb 559.4 min, recorded in minutes of the franchise during these periods, getting an average of 31.29% idle underutilized by the company in this period of 3 months.

Regarding Table 2, working with data from 2017, where there was use of 702.6 min in March, 763.8 min in April and 687.3 min in May, used for conversation, still has an average of 28.21% under-analyzed period for 3 months. Table 3 displays the detailed spending data, where the overall average is 29.75% and 70.25% used in conversation in relation to the LDN. In relation to local minutes can be viewed in Table 4. When the local franchise of 4000min, in Tables 1 and 2, the results are more aggressive in terms of under-spending in December 2016 used only 243 min, with an idle timeout of approximately 94% in January 2017, value was 1375.2 min, falling to 22.78 min in February and March the minutes used .3 são 1489 min, in April there was no local calls for fixed and finally in May was only 16.4 minutes. Following the Tables 1 and 2, evaluating the universal number 0800, in all the months studied was paid the same R\$ 70.36, which is related to the rate of the service, regardless of whether or not to use the service. There are charges to receive calls, that is, it's free to the originator and paid in full by the receiver when using the 0800.

Analyzing invoices available, costs were calculated per minute. For calculating average values were used per minute, as are varied according to the time and source type and AREA CODE of origin or destination, in the case of the DDR franchise LDN, the calculated cost is R\$0.24 per minute in terms of operator OI with the competing proposal comparative Algar, obtained the value of R\$0.08 per minute LDN and finally the VOIP operator Setetel cost R\$0.03 per minute LDN expressed in Table 5. Also in Table 5, there are the calculations for the following data, as the franchise of minutes sites that calculated cost R\$0.09 per minute in operator OI, R\$0.05 in Algar and 0.03 in carrier VOIP operator Setetel. In the analysis, the return values of calls to charge are significantly higher, reaching R\$3.51 per minute, when received from the mobile operator TIM. The other carriers cost R\$2.07 for mobile Live and mixed calls billed as VC1, VC2 and VC3 had average R\$0.41 per minute. There is the option of using the number 0800 Universal via VOIP, that is have a line that accepts external links and with the cost per minute less than conventional carriers, the Direct call operator offers plans that would become viable in larger volumes of links for the moment it would not be feasible to purchase of the service, because it costs R\$299.00 of service activation fee (one-time payment) and more tuition R\$129.00 more R\$75.00 minutes package totaling in the first payment R\$503.00 and after R\$204.00 monthly. The comparison of cost per minute can be seen in Table 5. By analyzing the Hunter branch, grouped by main number of the array, and present in the Table 1 and 2, the rate of use of the telephony service is R\$64.73 and it covers 300 minutes of local calls. In the first month were used 189.5 min, i.e. sites speaking of Hunter to Hunter. In the second month, 50.8 min in the third month were 71.1 min, in the fourth month were 146 min, in the fifth month were 152 min. The average use was 121.8 min, i.e. 59.40% local usage.

Table 1. Analysis of the costs Obtained through the invoices during the period from 11/11/16 to 10/02/2017

Company	Period 11/11/2016 à 10/12/2016			Period 11/12/2016 à 10/01/2016			Period 11/01/2017 à 10/02/2017		
	Cost Invoice	Used Minutes	Cost Per Minute OI S/A	Cost Invoice	Used Minutes	Cost Per Minute OI S/A	Cost Invoice	Used Minutes	Cost Per Minute OI S/A
franchise DDR LDN 1000 min	238.26	744.70	0.24	238.26	757.20	0.24	238.26	559.4	0.24
Franchise 4000 min 10 CH	373.16	243.00	0.09	373.16	1375.20	0.09	373.16	22.78	0.09
the charge - landline	-	-	-	-	0.000	-	-	0.00	-
the charge - Mobile Vivo	-	-	-	-	0.00	-	9.02	4.08	2.21
the charge - mobile TIM	-	-	-	-	0.00	-	14.33	4.08	3.51
the charge - (Mixed VC1. VC2. VC3)	16.45	44.51	0.37	18.52	50.88	0.36	69.70	191.700	0.36
Other value	18.59			20.76			18.73		
Universal Number 0800	70.36			70.36			70.36		
0800 fixed location	0.38	0.97	0.39	0.54	2.67	0.20	0.31	1.55	0.20
0800 Fixed intercity	0.33	0.50	0.66	-	0.00	-	2.51	6.42	0.39
0800 Mobile	6.84	7.05	0.97	5.10	1.75	2.91	3.85	3.60	1.07
Other value	2.38			2.24			2.32		
grouped row 7029									
Franchise Oi Pro 10MB	105.07			105.07			105.07		
Franchise, 6000 min Comp,	127.28	0.00	0.021	127.28	0.00	0.021	127.28	0.00	0.021
Other value	7.96			7.09			6.93		
Work in Caçador City									
non-residential basic,(300 min)	64.73	189.50	0.180	64.73	50.80	0.180	64.73	71.10	0.180
Internet Oi 1MB/5MB	86.51			86.51			86.51		
Intercitys	3.17	0.93	3.40	31.36	48.65	0.64	23.27	36.75	0.63
Mobile VC1	-	0.00	-	1.33	1.72	0.77	0.37	0.23	1.59
Mobile VC2	-	0.00	-	-	0.00	-	-	0.00	-
Other value	4.54			5.30			4.60		
Total	1,092.54			1,122.22			1,188.73		
Other value Total	33.47			35.39			32.58		
Total invoiced OI	1,126.01	Note: Value included internet + telephony		1,157.61	Note: Value included internet + telephony		1,221.31	Note: Value included internet + telephony	

Source: Authors, 2018.

Table 2. Cost Analysis Obtained through the invoices during the period from 11/02/17 to 10/05/2017

Company	Period 11/02/2017 à 10/03/2017			Period 11/03/2017 à 10/04/2017			Period 11/04/2017 à 10/05/2017		
	Cost Invoice	Used Minutes	Cost Per Minute OI S/A	Cost Invoice	Used Minutes	Cost Per Minute OI S/A	Cost Invoice	Used Minutes	Cost Per Minute OI S/A
Franchise DDR LDN 1000 min	238.26	702.60	0.238	238.26	763.80	0.24	238.26	687.30	0.24
Franchise, 4000 min 10 CH Locais	373.16	1489.30	0.093	373.16	0.00	0.09	373.16	16.41	0.09
the charge - landline	-	0.00	-	-	0.00	-	-	0.00	-
the charge - Mobile Vivo	4.59	2.38	1.93	-	0.00	-	-	0.00	-
the charge - mobile TIM	-	-	-	-	0.00	-	-	0.00	-
the charge - (Mixed VC1. VC2. VC3)	12.36	15.63	0.79	19.26	65.35	0.29	28.08	95.40	0.29
Other value	2.32			20.97			2.32		
Universal Number 0800	70.36			70.36			70.36		
0800 fixed location	0.96	4.85	0.20	0.38	0.82	0.47	0.73	3.15	0.23
0800 Fixed intercity	0.66	1.27	0.52	2.65	6.25	0.42	3.04	8.93	0.34
0800 Mobile	4.04	4.17	0.97	7.11	5.90	1.21	4.61	4.75	0.97
Other value	2.18			2.29			2.50		
grouped row 7029									
Franchise Oi Pro 10MB	105.07			105.07			105.07		
Franchise, 6000 min Comp,	127.28	0.00	0.021	127.28	0.00	0.021	127.28	0.00	0.021
Other value	6.69			6.93			7.64		

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Work in Caçador City non-residential basic,(300 min)	64.73	146.00	0.18	64.73	493.00	0.18	68.15	152.00	0.19
Internet Oi 1MB/5MB		86.51			86.51			90.18	
Intercity Landline	26.77	43.68	0.61	44.18	72.08	0.61	33.28	49.25	0.68
Mobile VC1	0.37	0.17	2.23	0.81	1.03	0.78	-	0.00	-
Mobile VC2	9.43	4.68	2.01	79.01	40.53	1.95	-	0.00	-
Other value		5.29			5.20			6.17	
Total	1,115.12			1,139.76			1,142.20		
Other value Total		16.48			35.39			18.63	
Total invoiced OI	1,131.60	Note: Value included internet + telephony		1,175.15	Note: Value included internet + telephony		1,160.83	Note: Value included internet + telephony	

Source: Authors, 2018.

Table 3. Analysis of use of LDN franchises of the OI

LDN Franchise	Period 1		Period 2			Average min. Used	Average min. In under-utilisation
	10/16	Jan/17	Feb/17	Mar/17	APR/17		
Minutes Used	74.47%	75.72%	55.94%	70.26%	76.38%	68.73%	70.25%
Min. Underutilized	25.53%	24.28%	44.06%	29.74%	23.62%	31.27%	29.75%
The average Period		31.29%			28.21%		

Source: Authors, 2018.

Table 4. Analysis of use of Local minutes franchises of the OI

Local Franchise	Period 1		Period 2			Average min. Used	Average min. In under-utilisation
	10/16	Jan/17	Feb/17	Mar/17	APR/17		
Minutes Used	6.08%	34.38%	0.57%	37.23%	0.00%	0.41%	13.11%
Min. Underutilized	93.93%	65.62%	99.43%	62.77%	100.00%	99.59%	86.89%
Average Period		86.33%			87.45%		

Source: Authors, 2018.

Table 5. Comparative cost per minute

Array	Cost per min OI *	Cost per min Algar	Cost per min Setetel VOIP	Cost per min Directcall VOIP
DDR Franchise LDN	R\$0.24	R\$ 0.08	R\$ 0.03	R\$-
Franq. 4000 min 10 CH Sites	R\$0.09	R\$ 0.05	R\$ 0.03	R\$-
Collect – Fixed	R\$-	R\$ 0.89	R\$-	R\$-
Collect-Living Mobile	R\$2.07	R\$ 0.89	R\$-	R\$-
Collect-Mobile TIM	R\$3.51	R\$ 0.89	R\$-	R\$-
Charging (VC1 VC2 VC3,, Joint)	R\$ 0.41	R\$ 0.89	R\$-	R\$-
0800 Local Fixed	R\$ 0.28	R\$ 0.10	R\$-	R\$ 0.30
0800 Long-distance Fixed	R\$ 0.47	R\$ 0.10	R\$-	R\$ 0.30
Mobile 0800	R\$ 1.35	R\$ 0.85	R\$-	R\$ 1.04
Franq. 6000 min Comp.	R\$ 0.02	R\$ 0.05	R\$ 0.03	R\$-

Source: Authors, 2018.

The affiliate long distance calls are billed according to the destination of the calls that are made, which can be for fixed or mobile long distance. In six months of analysis, the average cost was R\$0.58 per minute for local calls, long distance calls per minute R\$1.64 and mobile phone average was R\$4.89 per min by Hunter, local and long distance calls for mobile that can be VC1VC2 or VC3. At the branch noted the oscillation of long distance use, because in the first month was used less than 1 min, totaling the total cost of R\$3.40. In the second month, the value has grown significantly and is of R\$31.36 by 48.65 min of talk time. In the third month was R\$23.27 for 36.75 min. In the fourth month analyzed were spent only R\$26.77 by 43.68 min of conversation in the fifth were R\$44.18 with 72.08 min of talk time and finally the sixth month cost for R\$49.25, 33.28 minutes of calls. The average cost R\$23.57 and 41.89 minutes in calls. Even with the analysis there was no affiliate links for mobile in December 2016, in January 2017 R\$1.33 cost, by a 1.71 min, in the month of February was 0.23 min, totaling and R\$0.37 in the month of March had two speed VC1 that yielded a total cost of R\$0.37 for less than 1 min and also that yielded VC2 cost R\$9.43 per min 4.68 in April no links to mobile telephony.

Analysis of Internet Plans: On the evaluation of internet plans two internet links currently signed and the main link is provided by GVT (Alive), features 50Mbps download and upload, it has a 5Mbps dedicated line to enable the installation of the plans, line that has 100% idleness, causing injury in the real use of the resource. The background of the internet is provided by OI S. A. and has 10 Mbps of download speed with only 1Mbps upload, has IPfixo and is being used as secondary to fail over cases, costing R\$105,07 monthly. The speed is insufficient for the needs of the company, and there is no willingness to increase speed, for this reason is as secondary link. There is a need for a line to the internet installation, which grouped the main line of the construction company and has 6000 min franchise locations for calls that are currently 100% unusable, causing a prejudice to 127.28 average per month, in these six months of the study the damage total was R\$763.68. Table 6 shows the costs of the plan used and the proposal of the Algar.

Table 6. Analysis of Internet plans

Operator	Plan (Mbps)	Monthly value	Value of line	Total
GVT Alive	50/5	R\$ 131.20	R\$ 79.94	R\$ 211.14
GVT Alive	Fixed Ip	R\$ 50.00		R\$ 50.00
OI S.A.	10/1 (pro IP.)	R\$ 105.07	R\$ 127.28	R\$ 232.35
Algar (Proposal)	200/80	R\$ 324.50		R\$ 324.50
Subtotal Alive		R\$ 261.14	Installed	R\$ 493.49
Subtotal OI S.A.		R\$ 232.35	Installed	
Subtotal Algar		R\$ 324.50	Proposal	R\$ 324.50
Reduction				R\$ 168.99

Source: Authors, 2018.

Analysis of the Telephony Plans: Currently, the construction company has a business plan with the carrier OIS. A., where the average monthly cost is R\$1,162.09, distributed among the contracted services including DDR (direct inward dialing) with 10 channels, the local 4000min with 10 franchise channels. In the DDR these branches are straightforward, i.e. you can connect with the end of the desired extension number, for example to call 3251-0100, will play the first track extension, i.e. usually at extension of the operator or main branch of the company, but when you call 3251-0110, the call will ring directly at extension 110 as the PBX numbering plan, in this

case it is obligatory the use of a telephone exchange PABX. Has universal 0800 number, that generates a fixed cost of R\$70.36 just to keep the service up and running more adding charges for receiving calls, which ends up making expensive plan, which collates the main invoice as well as two more lines, where a is used to make the internet plan, being 100% useless generating losses. The remaining line belongs to the Branch Office established in Hunter, which currently comes generating high costs with long distance and mobile, as well as the internet. The operator OI has a long contract with the construction company, where the service remains unchanged for a long time, thus keeping the outdated values with high deductibles that most often is underutilized or used too much, generating higher costs. Commercial representatives of two carriers came to the company in order to analyze the current scenario and better understand what was in use at the moment and the final value paid currently. The proposals are aimed at reducing costs by providing equivalent services or higher. The company that more attention in terms of price, availability and quality of operation is the Algar. Algar is a company that operates in several States of the country's more than six decades working in the business and has approximately 1.3 million customers and is 100% Brazilians, showing efficient and robust solutions with high availability via fiber speed Optics in the service. Its operation in Lages the business focus, where it operates in order to make 16 rows per DSLAM (Digital Subscriber Line Access Multiplexer) in the current scenario, by limiting the number of customers in order to guarantee the quality of the contracted plan. The proposal suggested to the construction company concerned is expressed in Table 7, where the objective is to obtain lower cost in relation to the current contracted plan. The migration can be made in alternative schedules, so as not to affect the telephone during office hours of the construction. The amount of available channels is larger compared to HEY, as well as the availability of the internet. Were offered to 200Mbps with 80Mbps upload, with the band hired quality assurance, becoming a viable option, safe and low cost in relation to the current plan hired operator OI.

Table 7. Algar Telecom Proposal

Current proposal Algar Telecom			
Product	Amount	R\$	OBS
Link Fib Optica	200Mb	324.50	
Tronco E1	30 Lines	550.00	
Fixed Local		0.01	Including Taxes
LDN Fixed		0.06	Including Taxes
Tax Installation	FREE	FREE	
Total		874.50	
Product	Amount	Franchise	Install
TrunkE1	30 Lines	400.00	1,424.00
TrunkE1	30 Lines	450.00	1,040.00
TrunkE1	30 Lines	500.00	400.00
Local Fixed		0.05	
LDN Fixed		0.08	
OBS: * Tax Install Portion 12X			
* Valid Rates Using CSP (DDD) 012			
Warranty of 40% Upload of Contract Link			

Source: Authors, 2018.

Table 8. Main costs of current plan OIS. A

Operator	Service	Current Cost
OI S. A.	DLD 1000 Min.	R\$ 238.26
OI S. A.	Local min 4000	R\$ 373.16
OI S. A.	Grouped line (internet)	R\$ 127.28
OI S. A.	Grouped line (0800)	R\$ 70.36
OI S. A.	Grouped line (branch)	R\$ 68.15
Subtotal OI		R\$ 877.21

Source: Authors, 2018.

Table 9. Scenario 1 of proposal-amount of minutes for value

Operator	Service	Proposed cost
Algar Telecom	Franchise LDN 8333.3 Min	R\$ 500.00
Algar Telecom	Local franchise 5000 min	R\$ 50.00
VOIP Setetel	Premium VOIP TDM LDN/min 8000 Site	R\$ 240.00
Subtotal		R\$ 790.00

Source: Authors, 2018.

Table 10. Scenario 2 of the proposal – amount of minutes for value

Operator	Service	Proposed cost
Algar Telecom	Franchise LDN 3125 Min	R\$ 250.00
Algar Telecom	Local franchise 5000 min	R\$ 100.00
VOIP Setetel	Premium VOIP TDM LDN/Local 5000 min	R\$ 150.00
Subtotal		R\$ 500.00

Source: Authors, 2018

Table 11. Investment scenario 1

Investment in scenario 1 Hardware (via Internet)	QTY	Un Costs.	Freight	Total
33185 BalunBnc Media Converter E1 RJ45	1	R\$ 54.90	R\$ 23.90	R\$ 78.80
Dual E1 card 60 Digital Xt 130 Central Trunks or Xt200	1	R\$ 200.00	R\$ 19.90	R\$ 219.90
E1 card Asterisk Pci Tel110p 30 Rows DigistarReidoasterisk	1	R\$ 562.00	R\$-	R\$ 562.00
Technical Services (calculated value: time)	18	R\$ 120.00	R\$-	R\$ 2,160.00
Subtotal				R\$ 3,020.70

Source: Authors, 2018.

Table12. Investment scenario 2

Hardware investment scenario 2 (via Internet)	QTY	Un Costs.	Freight	Total
Grandstream 8 FXS Gateway	2	R\$ 890.00	R\$ 25.28	R\$ 1,805.28
8 Analog Trunks DigistarXt card 130 Or 200 (used)	2	R\$ 300.00	R\$ 19.90	R\$ 619.90
Technical Services (calculated value: time)	15	R\$ 120.00	R\$-	R\$ 1,800.00
Subtotal				R\$ 4,225.18

Source: Authors, 2018.

Table 8 displays the main OI phone plan costs, where it is just fixed monthly values without accrued interest, and intercity calls collect. Considering the services and values present in Table 8, you can reach some of the combinations of possible plans using the commercial proposals of Algarand VOIP, whereas the highest value of R\$550.00. Get the number of minutes that can be used in accordance with the value of the franchise in Table 9. Table 10 presents the values adjusted and calculated according to the required for the current moment of construction.

Current Telephony Hardware Scenario: The existing central is a Digistar XT200, produced in our country is one of the best solutions in cost-benefit of the market. Installed on site, has 6 plates with 12 branches and a plate with 8 totaling 80 analog extensions available, has two cards with 4 stem lines each with 3 GSM gateways (equipment that make the connection interface to use cell phone chip in order to cheapen the cost of mobile calls) connected with 1 chip Alive, each and a plaque for E1 with a capacity of 30, these channels are in use only 10 channels in the current plan provided by operator OI S.A.

Hardware investment for Voip deployment: The investment Tables display the three scenarios of possible investment in order to meet the VOIP service, being the fixed technique time values according to the specialized technical class available in the city of Lages. In Table 11, is the first scenario where there is a low-cost option, where will be harnessed to local infrastructure by adding a server IPBX (Internet Protocol Branch Exchange) to manage the links, where the will be integrated with the central local telephone, making the outgoing calls are directed to the VOIP trunk leaving the link cost.

For the interconnection with the analog Center will need the replacement of existing E1 card 30 channels for a double plate with 60 channels, support in this way will be the 30 channels offered by a carrier and the 30 available channels by IPBX, VOIP plan proposed no limit of concurrent calls, and so the limit is that Center will make up to 30 concurrent calls going out for VOIP, the other will use the conventional telephony interface E1 output. In the second scenario, Table 12, is a simplified scenario, where for VOIP deployment will require 2 FXS VOIP/SIP Gateways that will do the conversion of voice data packets to communicate with the central 8 outputs with analog RJ 11 each so transparent to users. You will need the addition of two boards with 8 analogue lines each stem so that the plant get the rows from the gateways. In this scenario it is not necessary to add servers. In Table 13, is the third scenario where the total replacement of the existing central for a new updated and with many current resources. In the first budget directed the purchase would be via the internet (Table 13) and second (Table 14) through a company of Lages (SC) specializing the best value chosen is Intelbras 140, Impacts be modular you can choose the modules of accordance with the need of the company, with the latest technology and manufacturing as well as Brazilian technical support facilitated. The necessary modules are from E1 to the connection to the digital lines of the operator, a Board with 8 analog trunks to connect to lines or GSM gateways, four plates with 16 branches to supply the quantity present in existing base plate for installation of VOIP Telephony without the need of a server part, 2 plates of codec for SIP/VOIP, VOIP extensions license keys, these extensions that can be accessed from anywhere via internet and the hardware key for trunks 4/10 extensions that enable the physical cards.

Table 13. Investment scenario 3 (budget via internet)

Cenário de investimento em Hardware 3 (via Internet)	QTY	Cost	Freight	Total
Phone Central Intelbras Impacts 140	1	R\$ 2,706.24	R\$ 62.19	R\$ 2,768.43
16 analog Extension card Impacts 140	4	R\$ 1,406.10	R\$ 47.84	R\$ 5,672.24
E1 Trunk Card To Central Impacts	1	R\$ 1,517.10	R\$ 16.52	R\$ 1,533.62
8 card Analog Trunks Intelbras Impact 140/220	1	R\$ 899.00	R\$ 22.90	R\$ 921.90
Base plate 30 Icip 4990195	1	R\$ 2,359.90	R\$ 62.95	R\$ 2,422.85
ICIP 30 Codec Board	2			R\$-
Hardware key 4990523 4 Trunks/Icip 10 Extensions	2	R\$ 1,070.00	R\$-	R\$ 2,140.00
Ext IP License	5			R\$-
Technical Services (calculated value: time)	24	R\$ 120.00	R\$-	R\$ 2,880.00
Subtotal				R\$ 18,339.04

Source: Authors, 2018.

Table 14. Investment scenario 3 (budget in specialized company)

Budget in Lages (HD Lages)	QTY	Per unit	Freight	Total
Digital Central INTELBRAS Impacts 140	1	R\$ 2,759.15	R\$-	R\$ 2,759.15
Stem Plate NKMC 22000 8 TR	1	R\$ 1,324.90	R\$-	R\$ 1,324.90
Analog Extension Card NKMC 22000 16 Extensions	4	R\$ 1,454.49	R\$-	R\$ 5,817.96
Interface 1E1 R2/RDSI 140/220 Impacts	1	R\$ 1,966.52	R\$-	R\$ 1,966.52
Hardware Key Icip 4 Trunks/Extensions ICIP Baseplate	1	R\$ 1,101.20	R\$-	R\$ 1,101.20
Base Plate 30 ICIP	1	R\$ 2,047.79	R\$-	R\$ 2,047.79
Icip 30 Codec Board	2	R\$ 576.27	R\$-	R\$ 1,152.54
For Ext Ip (by extension)	20	R\$ 72.55	R\$-	R\$ 1,451.00
Technical Services (calculated value: time)	24	R\$ 120.00	R\$-	R\$ 2,880.00
Subtotal				R\$ 17,621.06

Source. Authors, 2018.

Table 15. Analysis of economic feasibility Payback

Investment proposals	1 year	Year 2	Year 3
Final cash flow	6,554.40	6,554.40	6,554.40
Accumulated cash flow 1	R\$ 3,020.70	3,533.70	10,303.86
Accumulated cash flow 2	R\$ 4,225.18	2,329.22	8,883.62
Accumulated cash flow 3	R\$ 18,339.04	11,784.64	5,230.24
Accumulated cash flow 4	R\$ 17,621.06	11,066.06	4,512.26
PAYBACK1	Year: 0	Month: 5	Day: 15
PAYBACK2	Year: 0	Month: 7	Day: 22
PAYBACK3	Year: 2	Month: 9	Day: 17
PAYBACK4	Year: 2	Month: 8	Day: 7

Source: Authors, 2018.

Table 16. Investment Analysis NPV and IRR

Proposals	Investment	Profit	VPL	IRR
Proposal 1	R\$ 3,020.70	19,663.20-3 years ago	R\$ 12,455.24	209.67%
Proposal 2	R\$ 4,225.18	19,663.20-3 years ago	R\$ 76,112.50	144.51%
Proposal 3	R\$ 18,339.04	26,217.60	R\$ 1,156.83	16.00%
Proposal 4	R\$ 17,621.06	26,217.60	R\$ 8,118.74	18.03%

Source: Authors, 2018.

In Tables 15 and 16, the analysis of economic viability of the investment. Worked with 4 investment scenarios. In scenario 1, the value of the investment is R\$3,020.70 and will generate a payback of 5 months and 15 days of return and a NPV of R\$ 12,455.24 and a TIR of 209.67%. In scenario 2, the value of the investment is R\$4,225.18, the payback happens in 7 months and 22 days and the NPV is R\$ 76,112.50 and the IRR is 144.51%. In scenario 3, the value of the investment is R\$ 18,339.04 the payback happens in 2 years, 9 months and 17 days and the NPV is R\$ R\$ 1,156.83 and the IRR is 16,00%. In Scenario 4, the value of the investment is R\$ 17,621.06, the payback happens in 2 years, 8 months and 7 days and the NPV is R\$ 8,118.74 and TIR is 18.03%. The interest rate used was of 13% and was not considered the effects of inflation and depreciation, because he works with the prospects of saving values in telephone bills.

Conclusion

Telephony plans franchises would be beneficial only if there was a proportional usage, and with minimum margin, as is the

case of the franchise operator LDN OI. Were spent on average 702.5 min for conversation, close to 1000 min available for use within the franchise leaving 297.5 min margin available while maintaining a smaller margin without paying. Already in relation to the minutes, places the average 524.45 min used in a 4000 min franchise, that is, they 3476 min unused with the fixed cost of 373.16 that keeps generating injury to the integral construction. So it can be made possible the reduction of costs, will be held the E1 service with 30 channels of Algar. As the relief proposed by the carrier would be too over dimensioned in terms of minutes, make a proposal to use R\$350.00 dedicated to LDN and Local telephony. To achieve the best result at a lower cost in relation to the universal number 0800, the recommended is to use along the franchise operator Algar, because the monthly cost is lower and the cost per minute, making it the best solution currently available in relation to demand for current services. Upon receiving the proposal from the Gate operator, were carried out analyses of the economic and technical aspects for migration and portability, as well as the infrastructure and central support Digistar, in

order to verify that the system will be compatible 100% functional. In terms of VOIP, is a low cost solution with high efficiency, since it considered the minimum criteria to Link to the correct operation, will bring significant savings due to the fact I don't have fixed franchise, credit will only available as a prepaid system, then will be discounted per-minute cost franchise present in Table 5 of the total value of the plan in the Tables 9 and 10. Were carried out several quotes and research regarding the options available to meet the new demand of the addition of VOIP service, one of the investments is the investment scenario 1 present in Table 15, as well as possess the lowest cost for deployment, has several additional benefits when used an Asterisk server.

To manage effectively the speed of call offering more control of the team in order to adjust the plan with the company's current need of transparently to the user. Has greater benefits in respect of the other, because of lower costs, with additional lines for branch offices, because through the Asterisk can create virtual extensions that can be used anywhere on the planet via the internet, and communicate with the company at no cost, as in a local branch, and when necessary conduct calls there will only cost the VOIP plan discounted claims of franchise chosen by construction. Other solutions may be viable according to the need of future construction, because the present moment does not allow an investment of this magnitude.

Stands out as best alternative option the investment scenario 3 present in Table 15, which is more expensive and requires the installation of new central with all the current features and low maintenance. About internet plans, GVT alive, there is no availability for the speed boost, then the interest in Algar proposal was immediate when considering the relatively low cost in view of the speed of Algar is four times higher. The internet plan of OI 10Mbps is in secondary character to use only if the main go into failure. To hire the Grotto which will provide carrier plan internet via fiber optic, 200Mbps will be disabled both current plans reducing the cost in R\$168.99 as shown in Table 5. The fact that enables the replacement of current plans for just one is the fact that the operator have low resolution time benefit of calls (until SLA 12:00 am). The construction company has some mobile data plans with 3G modems which do not ensure the reliability of the system.

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