

Evaluation of Telephone Access Service Contrasts in Saudi Arabia: Riyadh Region Versus Southern Region

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Abstract. This paper is concerned with the practical evaluation of the present state, and the future development requirements of telephone access service, for different cases in Saudi Arabia. A general methodology has been derived for this purpose. The methodology is applied to the various urban, semi-urban, and rural areas of both the Riyadh region and the Southern region, and to the whole country level, in order to obtain a comparison reference. The telephone access service contrasts of the two regions have been emphasized, and a future plan for closing the gap between the two regions has been derived using two different development scenarios to achieve satisfactory level of service at a specific target date.

1. Introduction

1.1. Telephone Services in Saudi Arabia

During the past ten years, many major ambitious development plans have been implemented in Saudi Arabia; with one of such plans being related to telecommunications [1,2]. An example of the results achieved, is that the number of working telephone lines was increased by around five times, raising from around 200,000 lines in 1978 to 950,000 lines in 1987 [2-4]. However, due to various reasons, including those related to the geography of the country, the socio-demographic characteristics of the population, and the business activities, telephone services were not evenly distributed over the different parts of the country.

1.2. This Paper

The objective of this paper is to evaluate, the present state, and the future development requirements of telephone access service for two main regions of Saudi Arabia, on the light of the overall development of the whole country. The chosen regions are: the Riyadh region, and the Southern region. The two regions have the same total population, but with different urban, semi-urban, and rural population distribution [5-7]. In addition, the two regions are substantially different from one

another with regard to the present telephone access service. While the Riyadh region is on the upper side of the service level in the country, the Southern region is on the lower side of it [2-4]. The work involves the development of an evaluation methodology, on which the practical investigations, of the two regions, are based, to achieve the required objectives.

2. Evaluation Method

2.1. Basic Stages

Fig. 1 shows the various stages of the evaluation method considered here. The method includes two main consecutive sets of stages. The first is related to the evaluation of the present state of service, with emphasis on the contrast between the cases considered; while the second set of stages is concerned with the evaluation of the future development needed to close the gap of the contrast. The future development stages consist of stages related to identifying an overall future development plan, and stages concerned with the evaluation of different future development scenarios.

2.2. Evaluation of Present State

The first essential stage in the evaluation of the present state is to identify the factors involved. Such factors are to be considered for the various evaluated regions, including the different areas in each region, such as urban, semi-urban, or rural areas. In addition, the factors should also be considered for the whole country level, as this would provide a reference on the average state of telephone access in the country.

The factors considered are;

- **Population factors**, including the total population, and the population proportions for the various regions and areas considered.
- **Telephone access development factors**, which are related to the growth of the number of working lines installed in recent years, and the proportions of their distribution to the various regions and areas considered.
- **Telephone access service factors**, which include the present number of working lines, and the proportions of their distribution to the various regions and areas. In addition, these factors also include a factor for the evaluation of the access service level provided, that is the density of working lines per 100 population.
- **Availability of access factors**, which include the number of lines available in the local exchanges, but not available for access (may be due to the lack of local networking). An evaluation factor is also considered here, that is of the increase in the service density, which can be achieved, if such lines are put into service.

It can be seen that some of the above factors require data collection, while the others use the collected data to generate information on the relative state of the vari-

Evaluation of
the present
State

IDENTIFY FACTORS INVOLVED
IN THE EVALUATION OF
THE PRESENT STATE



COLLECT DATA ON CASES
CONSIDERED



EVALUATE PRESENT CONTRAST
OF SERVICE LEVELS



Evaluation of the
future
Development

IDENTIFY FUTURE
DEVELOPMENT PLAN



IDENTIFY FACTORS INVOLVED
IN THE EVALUATION OF THE
FUTURE PLAN



COLLECT REQUIRED DATA
FOR THE FUTURE PLAN



① Investigation
of Different
Scenarios

IDENTIFY OR MODIFY A
FUTURE DEVELOPMENT
SCENARIO



DERIVE RESULTS



OTHER DEVELOPMENT
SCENARIOS



EVALUATE RESULTS

Fig. 1. A method for the evaluation of present contrasts of telephone access service, and the future development needed

ous regions and areas considered. This enables investigators to evaluate the contrast of provided service, so that the future development plans can be adjusted accordingly.

2.3.A General Plan for Future Development

A general plan of future development need to be identified at this stage so that the service contrast can be resolved. Such a plan can be based on planning the provision of satisfactory access service for the cases considered at a certain future date. For such a case two main factors have to be balanced against one another, taking into account the other factors involved. The two factors are the future growth of working lines: v , and the future year when satisfactory access can be achieved: T [8-12].

Recent research has produced the following formula for this purpose [10,11].

$$V(0) \prod_{t=0}^{t=T-1} [1 + v(t)] = \left\{ R(0) \prod_{t=0}^{t=T-1} [1 + r(t)] \right\} \left\{ P(0) \prod_{t=0}^{t=T-1} [1 + p(t)] \right\} \left\{ \frac{1}{G(0) \prod_{t=0}^{t=T-1} [1 + g(t)]} + \frac{W(0) \prod_{t=0}^{t=T-1} [1 + w(T)]}{M(0) \prod_{t=0}^{t=T-1} [1 + m(t)]} \right\} \quad (1)$$

The capital letters in the formula represent the factors involved, while the small letters represent the growth or change proportion of the corresponding factor for the year (t). The symbol (0) represent the factor for the year when ($t=0$). For our purpose here, this can be considered as the present year. It can be seen that the growth or change given by the formula for the factors concerned is of general nature (changing every year), so that the various types of change or growth strategies can be considered as special cases [10,11]. The time scale considered by the formula ranges over T years, as T is the future year when satisfactory telephone access can be achieved. The factors involved, other than V and T , are as follows [8-10]:

- R : telephone access interest per household or business office.
- P : population.
- G : number of persons per household.
- W : working population proportion.
- M : number of persons per business office.

The basic considerations used in balancing the above factors and the derivation of formula (1) are given in Table 1.

Table 1. The basic considerations used for the derivation of formula (1)

Basic consideration	Mathematical representation
The growth of any basic factor, $F(t)$, from the base year, $t=0$, to the target year, $t=T$, is considered under a variable annual growth proportion $f(t)$.	$F(T) = F(0) \prod_{t=0}^{t=T-1} (1+f(t))$
The number of lines required to provide satisfactory access service, at the target year, $E(t=T)$, can be expressed in terms of the various factors involved.	$E(T) = R(T) P(T) \left[\frac{1}{G(T)} + \frac{W(T)}{M(T)} \right]$
The number of working lines, $V(t)$, is required to grow so that it reaches the satisfactory number, $E(t)$, at the year, $t=T$.	$V(T) = E(T)$

The above factors depend on the population characteristics, and no accurate estimation for their future growth or change can be made. However, investigations of different scenarios can be performed, and the results of which can then be evaluated to provide some reliable views of the future.

2.4. Future Development Scenarios

A scenario here can be viewed as consisting of three main parts.

- Given information and data on the factors concerned. Such information may either be related to collected data and statistics, or it may be generally assumed to be true. This part of a scenario may also be a part of the general development plan; and therefore it can be considered as a common part of different scenarios that can be taken into account.
- Assumed future growth and change strategies for the various factors involved. Such strategies may be based on past changes, or on some similarities with other related cases; or it may be based on different expectation reasons. This part of a scenario is its own identity that leads to its future outlook.
- Generated information on the future development requirements.

3. Practical Evaluation

3.1. Present State

The factors considered above for the evaluation of the present state of telephone access service, have been investigated for both the Riyadh region, and the Southern region of Saudi Arabia. In addition, the factors have also been taken into account for the whole country level, whose access service represents the average service provided, which would be a useful comparison reference. Tables 2-a and 2-b show the present values of the factors considered for the various urban, semi-urban, and rural areas, of the whole country, and of the two regions considered. The various areas of each region are listed in Table 3, together with a definition for each type of area. From the given values the following have been concluded.

- For the past few years, since 1983, the Riyadh region proportion of the installed working lines, at the whole country level, is 17.5%. This is reasonable, since the population of the Riyadh region represents 18% of the country's total population. On the otherhand and for the same period of time, the Southern region received only 5% of the total installed lines, despite the fact that its population, like Riyadh, also represents around 18%.
- It can be seen from the values shown that the present level of service for the Riyadh region is higher than that for the Kingdom as whole in all types of area, urban, semi-urban, and rural, while for the Southern region it is less for all areas. At present the Riyadh region has around 27% of the working lines in the country, against 4.2% for the Southern region, despite their equal population.
- The service level for the urban part of the Southern region, is similar to that of the country as whole, but less than that of the urban part of the whole country. In addition the rural part of the Southern region, whose population accounts for 80% of the region population, receives less than one third of the service level, of the average service given for rural areas at the whole country level.
- Both the Riyadh region and the Southern region have unused lines in their local exchanges (may be due to the lack of local networking). The number of these lines for the Riyadh region is over twice as much as that for the Southern region.

3.2. A Future Development Plan

The objective of the general development plan considered here is to investigate the future growth of telephone access needed to reach a satisfactory level of access for the various areas of both regions on the light of the future development for the whole country at a specific future year T. The plan is based on the assumption that the satisfactory access level is achieved, when on average, every household or business office has a working telephone line; this leads to the following equation:

$$R = 1 \quad (2)$$

Table 2-a. The present state of telephone access for the whole Kingdom of Saudi Arabia.

Case	Population factors		Access Development			Access Service		Availability of access increase	
	Population	Population proportion % (of the Kingdom	Lines installed since 1963	Proportion of lines installed since 1963 % (of the Kingdom)	Working lines	Lines proportion % (of the Kingdom)	Density per 100 population	Lines not in use in the exchanges are in use	Density increase if lines of
K I N G D O M	4,750,000	47.50	150,000	75.00	760,000	80.00	16.00	220,000	4.63
I N U R B A N	500,000	5.00	20,000	10.00	110,000	11.58	22.00	55,000	11.00
R U R A L	4,750,000	47.50	30,000	15.00	80,000	8.42	1.68	65,000	1.37
T O T A L	10,000,000	100.00	200,000	100.00	950,000	100.00	9.50	340,000	3.40

Table 2-b. The present state of telephone access for the Riyadh and the Southern regions.

Case	Population factors			Access Development			Access Service			Availability of access increase	
	Population	Population proportion % of the Kingdom	Population proportion of lines installed since 1983	Lines installed since 1983	Proportion of lines installed since 1983 % (of the Kingdom)	Working lines	Lines proportion % (of the Kingdom)	Density per 100 population	Lines not in use in the exchanges	Density increase if lines of	Density increase if lines of
Urban	1,100,000	11.00	28,000	14.00	215,000	22.63	19.55	55,000	5.00		
Semi-urban	90,000	0.90	3,500	1.75	20,000	2.11	22.22	5,000	5.56		
Rural	610,000	6.10	3,500	1.75	19,000	2.00	3.11	9,000	1.48		
Total	1,800,000	18.00	35,000	17.50	254,000	26.74	14.11	69,000	3.83		
Saudi Urban	250,000	2.50	4,000	2.00	26,000	2.74	10.40	8,000	3.20		
U.Semi-urban	100,000	1.00	1,000	0.50	7,000	0.74	7.00	3,000	3.00		
TH R	1,450,000	14.50	5,000	2.50	7,000	0.74	0.48	17,000	1.17		
N Total	1,800,000	18.00	10,000	5.00	40,000	4.21	2.22	28,000	1.56		

Table 3. The various urban and semi-urban areas of the different regions of Saudi Arabia.

Region	Urban area*	Semi-urban area**	Rural area***
Riyadh region	Riyadh City	Al-Majmaah	A
		Al-Kharj	l
		Al-Dawadmi	
		Layla	O
		Afif	t
			h
			e
Southern region	Abha Jizan Najran Khamis Mushait	Abu Arish	r
		Baysh	
		Bishah	P
		Al-Khasib	l
		Sabya	a
		Samitah	c
		Sharorah	e
			s

*An urban area, is considered to be any city or town with a counted population of over 30,000 during the only official population census of 1974.

**A semi-urban area, is defined as above, but for towns with a population of over 5,000 and less than 30,000.

***Other areas.

For the investigation of different development scenarios, the following common assumptions have been considered.

- The population growth is based on a constant annual growth proportion:

$$p(t) = p \quad (3)$$

- Each of the following factors has a constant value: the number of persons per household, the working population proportion, and the number of persons per business office:

$$\begin{aligned} G(t) &= G \\ W(t) &= W \\ M(t) &= M \end{aligned} \quad (4)$$

- The telephone access service growth is based on a constant annual growth proportion:

$$v(t) = v \quad (5)$$

Under the above considerations equation (1) becomes:

$$V(0) (1+v)^T = R P(0) (1+p)^T \left(\frac{1}{G} + \frac{W}{M} \right) \quad (6)$$

From this equation, the required growth proportion v can be given, for any target year of reaching satisfactory access, as follows:

$$v = e^A - 1 \quad (7)$$

where

$$A = \frac{\text{Ln}(R) + \text{Ln}[P(0)] + T[\text{Ln}(1+p)] + \text{Ln}[(1/g) + (W/M)] - \text{Ln}[V(0)]}{T}$$

From v , the increase in the number of lines for the year t , where $0 < t < T$, can be given as follows:

$$N(t) = V(0) (1+v)^{t-1} v \quad (8)$$

The average of this increase per year, within the specified range of time will be:

$$N = V(0) [(1+v)^T - 1] / T \quad (9)$$

Under the assumptions considered, the proportion of increase in the number of lines required to keep the access service at satisfactory level considered, for $t > T$, should be equal to the population annual growth proportion, p . The increase in the number of lines for the year t , where $t > T$ becomes:

$$N(t) = V(0) [1 + v]^T (1+p)^{t-T-1} p \quad (10)$$

The progress of telephone density, based on v , for $0 < t < T$, can be given as follows:

$$D(t) = 100 V(0) (1+v)^t / [P(0) (1+p)^t] \quad (11)$$

At, $t = T$ the density becomes:

$$D = 100 V(0) (1+v)^T / [P(0) (1+p)^T] \quad (12)$$

This density would remain constant for $t > T$, if the number of working lines continues to increase in accordance with equation (10).

3.3. Investigation of Future Development Scenarios

The above analysis have been applied to the investigation of two future development scenarios, specified in Table 4. The scenarios have been chosen so that the first (I) provides an upper limit, while the second (II) gives a lower limit, for the future needed lines. Scenario I has a higher population growth; lower average number of persons per households, which leads to more households; higher working population proportion, and lower number of working persons per business office, which lead to more business offices. The future year of satisfactory access for both scenarios have been considered to be 20 years from now, (2007). The two scenarios have been applied to the urban, semi-urban, and rural areas of the whole country, and of both the Riyadh region, and Southern region. The required annual growth proportions, for the various areas considered, using the two scenarios, have been computed from equation (7); and the results are illustrated in a bar chart in Fig. 2.

Table 4. The basic considerations of the investigated scenarios.

Basic Considerations		
Factors	Scenario I	Scenario II
R	1	
	20	
T	Year: 2007	
P	3%	2.5%
G	5	6
W	35%	30%
M	5	6

Figs 3-a and 3-b illustrate the progress of the working lines needed and of their density, [computed from equations (8), (20), (11), and (12), after computing v from equation (7)], for the whole kingdom considering the two scenarios. Figs 4-a and 4-b, and Figs 5-a and 5-b, show the same for the Riyadh region, and the Southern region respectively. The results given provide a general idea on the future development

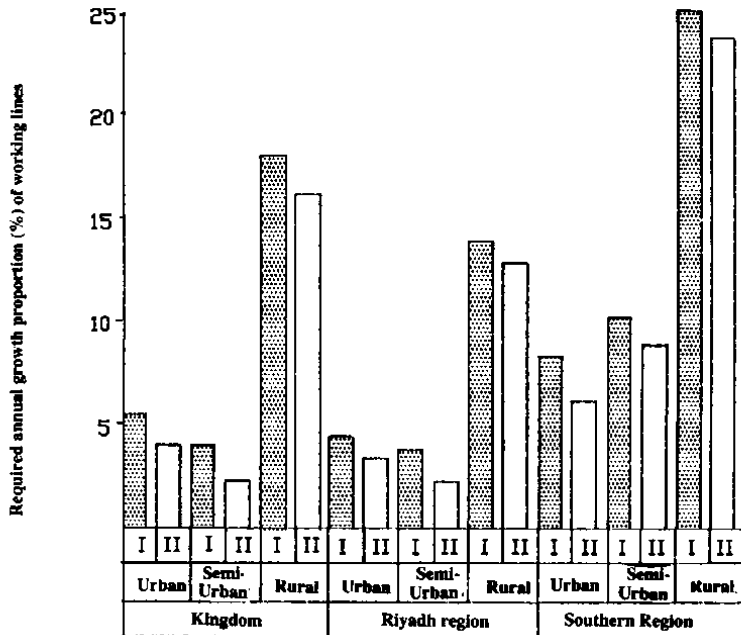


Fig. 2. A bar chart illustrating the annual growth proportion of working telephone lines required to achieve satisfactory level of access for the various areas considered, using the two identified future development scenarios (I) and (II)

required, at the given levels. It can be seen that, after the target year is reached and satisfactory access is provided, further progress in the working lines is needed to keep the service level, or the density, at its required value, [as given by equation (10)]. For scenario I this value is around 27 lines per 100 population, while for scenario II it is around 22.

A more detailed picture on the future development needed, is given in Tables 5-a and 5-b. These Tables provide the following information, for the urban, semi-urban, and rural areas, of the whole kingdom, the Riyadh region, and the Southern region, considering both scenarios, I and II:

- The total working lines needed until the year 2007.
- The average number of working lines needed per year.
- The proportion of required lines for the area concerned to the Kingdom's total.

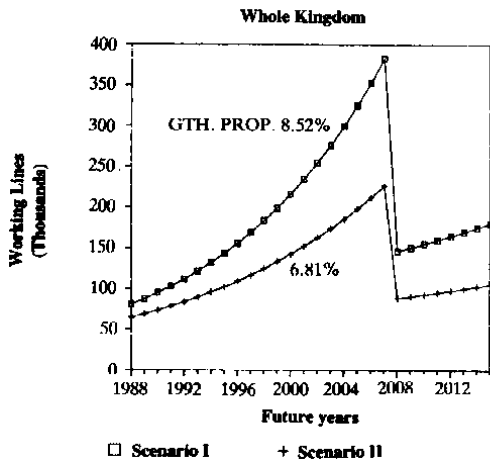


Fig. 3.a. The future working lines needed to reach satisfactory access at the year 2007, for the two scenarios

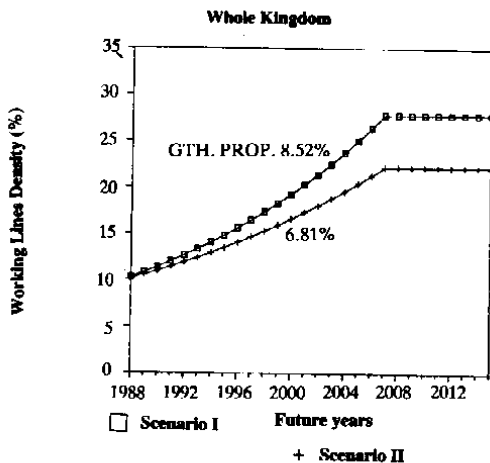


Fig. 3.b. The future progress of telephone density, for reaching satisfactory access at the year 2007, for the two scenarios

Riyadh region

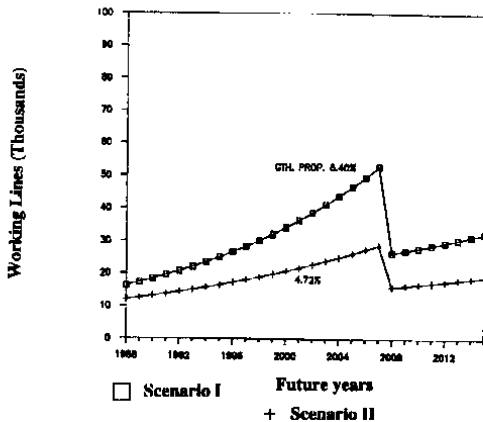


Fig. 4-a. The future working lines needed to reach satisfactory access at the year 2007, for the two scenarios

Riyadh region

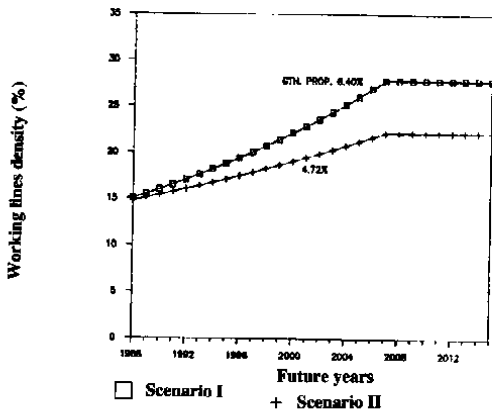


Fig. 4-b. The future progress of telephone density, for reaching satisfactory access at the year 2007, for the two scenarios

Southern region

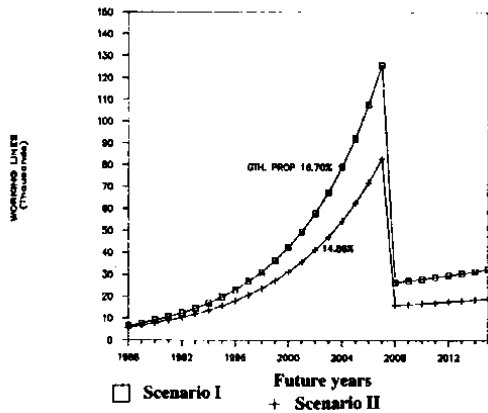


Fig. 5-a. The future working lines needed to reach satisfactory access at the year 2007, for the two scenarios

Southern Region

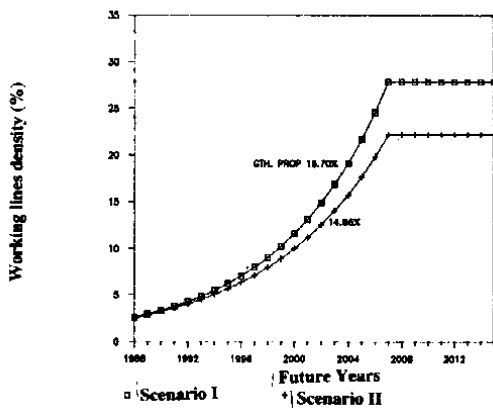


Fig. 5-b. The future progress of telephone density, for reaching satisfactory access at the year 2007, for the two scenarios

Table 5-a. Future telephone access development needed for the whole Kingdom of Saudi Arabia.

Case	Scenario I			Scenario II		
	Total working lines increase	Average working lines increase (per year)	Required line prop (Kingdom) (%)	Total working lines increase	Average working lines increase (per year)	Required line prop (Kingdom) (%)
Urban	1,556,212	77,811	39.65	924,574	46,229	35.59
Semi-urban	133,820	6,691	3.41	67,455	3,373	2.60
Rural	2,233,413	111,671	56.91	1,605,100	80,255	61.79
Total	3,924,379	196,219	100.00	2,597,823	129,891	100.00

K
J
N
G
D
O
M

Table S-b. Future telephone access development needed for the Riyadh region and Southern region. (Other Cases in the Kingdom)

	Scenario I				Scenario II			
	Total working lines increase	Average working lines increase (per year)	Required line prop (Kingdom) (%)	Total working lines increase	Average working lines increase (per year)	Required line prop (Kingdom) (%)	Total working lines increase	Required line prop (Kingdom) (%)
R	320,652	16,033	8.17	174,825	8,741	6.73		
I								
Y	23,822	1,191	0.61	11,951	598	0.46		
A								
D	278,201	13,910	7.09	199,939	9,997	7.70		
H								
	624,347	31,217	15.91	384,890	19,245	14.82		
S								
O	95,860	4,793	2.44	62,734	3,137	2.41		
U								
T	41,835	2,092	1.07	28,456	1,423	1.10		
H								
E	705,047	35,252	17.97	510,049	25,502	19.63		
R								
N	837,965	41,898	21.35	598,905	29,945	23.05		

4. Conclusion and Discussions

In this paper, a methodology for the evaluation of telephone access service contrasts in Saudi Arabia has been developed. The methodology includes a sequence of steps for the evaluation of the present state, and another sequence of steps for the evaluation of the future development requirements, including the investigation of different development scenarios. The application of the methodology to the Riyadh region, the Southern region, and the country as a whole, has shown that the present access service is not evenly distributed, and that further development to achieve satisfactory access is needed for the regions considered, and for the whole Kingdom. The future development has been investigated, and results on a development plan, with two different scenarios, for achieving satisfactory telephone access, with even distribution, have been concluded. For the objective of achieving satisfactory access in the year 2007, twenty years from now, the total number of lines required for the whole country would be around 3 million, with around 15% needed for Riyadh region and 22% for the Southern region.

The work presented in this paper has provided results on one issue related to the future planning of the Saudi telecommunication network, namely the future of telephone access requirements in the country. Other issues that would be important for future consideration include: the telecommunication traffic loads expected to be placed on the network, and the future technology to be used by the network. With respect to network traffic load, it is important to consider the user behaviour and the network capacity requirements. In addition, the network technology issue will be concerned with the study of the present network equipments, the technology trends including ISDN, and the gradual replacement of the older technology by the newer one.

Acknowledgement: This work was supported by Project No. AT-6-55 of King Abdulaziz City for Science and Technology, Saudi Arabia.

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(Manuscript Received: 2.10.1987; Accepted: 4.4.1988)

تقويم التباين في خدمة النفاذ الهاتفي بالمملكة العربية السعودية في منطقة الرياض والمنطقة الجنوبية

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ملخص البحث . يهدف هذا البحث إلى تقويم الحالة الراهنة، ومتطلبات المستقبل، الخاصة بخدمة النفاذ الهاتفي في المملكة العربية السعودية. ويقدم البحث في سبيل ذلك نموذجاً رياضياً وأسلوباً منهجياً محددًا، لدراسة مختلف الأجزاء المدنية، وشبه المدنية، والريفية لكل من منطقتي الرياض والجنوب، بالإضافة إلى المملكة ككل من أجل إيجاد مرجع وسطي للمقارنة. ويتم البحث بالتركيز على التباين في خدمة النفاذ الهاتفي المتوافرة في المنطقتين، ويقدم خطة مستقبلية لتأمين خدمة مرضية تغلق فجوة هذا التباين. وتستخدم هذه الخطة توجيهين مختلفين لتخفيف الخدمة المنشودة ضمن فترة زمنية محددة.