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A Decision Support Model to Determine the Contribution of Urban Region in the National Target Total Fertility Rate

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Abstract: This paper proposes a decision support model to determine the contribution of urban region in the National Target Total Fertility Rate using analytical hierarchical Process (AHP). The proposed model supports in regional sustainability developing regarding family planning programs by determining and reducing the contribution of each governorate in Urban region of TFR and its fertility rate taking into consideration its socio-economic context including women education level, precent of young women, infant mortality, age at first marriage, women working status, spouse level of education, family income and place of residence. The AHP is employed to determine the contribution of each governorate in the national target TFR and determine the most important and effective criterion within each governorate. These criteria include women educational level, women employment status, place of residence, family income and spouse level of education. All assessments of selected criteria are assessed using AHP by five experts' opinions in the domain of family planning to reflect its impact and contributions into governorate TFR. The proposed model is implemented in urban region of Egypt to disaggregate the national TFR into regional TFR to achieve its required reduction level. The obtained results showed that the proposed model performed well in reducing the regional level of TFR according to reduction of governorate TFR.

Key words: Fertility · National TFR · Urban region · Family planning · Socio-economic context · Disaggregation · Analytic Hierarchy Process

INTRODUCTION

Fertility is a complex adaptive phenomenon that results from the interplay of various social, psychological and cultural patterns related to employment, child mortality, contraceptive use, level of education and socio-economic development. National target total fertility rate (TFR) was determined during National Population Conference in 1984 by 2.1 Child per Woman by year 2017. To achieve national target each region have to reduce its fertility, which led to the importance of set target TFR for each region.

Balance between population growth rate and economic growth rate is a target for countries. Reduce Egypt population growth rate, the government of Egypt set up target total fertility rate for 2.1 children/women by year 2017.

Through previous study of same researchers they were able to disaggregate total fertility rate at national level to regional level by identifying contribution of each region in the national target. Findings of previous work showed that to achieve the national target total fertility rate of 2.1, Urban region have to reduce its fertility from 2.6 to 1.9. This disaggregation of target total fertility rate was based on level of several variables at these community that affecting total fertility rate.

To do that we consider TFR Bongaart formula and its variables which are: proportion of married women in reproductive age, the lactation infecundability, abortion, pathological sterility, contraception rate used among married women in reproductive age and total fecundity.

The Analytical Hierarchal Process approach was adopted, which is a comprehensive framework designed [1] to help decision makers incorporate qualitative (intangible) and quantitative (tangible) aspects of a complex problem. It systematically solves complex problems by decomposing the structure of a problem into hierarchies and then developed pair wise comparison judgments as to importance or preference to develop priorities in each hierarchy. The literature review showed

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that AHP approach applied in different areas but there were no previous applications in population/reproductive health/family planning area.

The aim of this paper is to develop a decision support model to disaggregating urban region target TFR level of Egypt into governorates regional target TF level using AHP. The urban region includes Cairo, Alexandria and Port-Said and Suez governorate. The rest of this paper is organized as: section 2 introduces the problem definition and background. The proposed assessment model is described in section 3. The implementation and results analysis of the proposed approach in presented in section 4. Section 5 is devoted to conclusion and further research.

Problem Definition and Background: Controlling total fertility rate is essential to reduce burden of population growth impact on different sectors such as health services, education, per capita income,….etc. During the National Population Conference in 1984, to reach replacement level (2.1 children) was determined as the national target for TFR.

According to latest Demographic and Health Survey (DHS) conducted on 2008 the current level reached 3.0 children per women [2], targets can be achieved by affecting many factors including increasing women education level, encouraging women for more participation in the work market and strengthening family planning program.

Even though, target TFR was determined at the national level but was not determined at lower levels (regional and governorate), the TFR varies among governorates and regions, so working on different factors to reduce TFR in these regions will reduce TFR differently in these regions and accordingly, reduce TFR at governorate level will reduce TFR at regional level. In this article an approach was suggested to disaggregate the regional targets to determine governorates targets'. This disaggregation has to consider the variation among these governorates at each region concerning identified criteria. To do that, the Analytical Hierarchal Process (AHP) technique will be used to disaggregate TFR the higher level will be the assessment of selected criteria which affected TFR reduction, the lower level will be to assess each region according to these criteria and these assessments will be done through group of experts (5 experts). Criteria were determined after doing literature review, research and survey's findings and consulting demographer experts.

To calculate TFR and factors affected TFR, a framework of the factors affecting fertility that recognized both indirect and direct determinants of fertility. In 1978, John Bongaarts developed these ideas in to a framework for analyzing the proximate determinants of fertility [Bongaarts, 1978] that explained the fertility-inhibiting effects of the key direct determinants. Bongaarts' work represented a significant advance over previous attempts in that it presented a simple model that could be readily applied using available data.

Although there have been some criticisms of this and other approaches [Reinis, 1992], the Bongaarts model remains one of the most widely used tools for analyzing fertility and fertility model Change.

Mathematical Model: The basic model of TFR is introduced it by Bongaarts, his original model included four proximate determinants: marriage, postpartum infecundability, abortion and contraception. In a later paper, Bongaarts added a fifth determinant, pathological sterility [Bongaarts, 1984].

$$TFR = Cm * Ci * Ca * Cp * Cc * TF \quad (1)$$

Where:

Cm : Is the index of proportion married,
Ci : Is the index of lactation infecundability,
Ca : Is the index of abortion,
Cp : Is the index of pathological sterility,
Cc : is the index of contraception and
TF : Is total fecundity.

These factors are behavioral and biological factors that influence fertility directly. Cultural, psychological, economic, social, health and environmental factors affect fertility indirectly through these proximate determinants.

Cm : the Index of Marriage: The index of marriage is intended to express the reduction in fertility caused by the fact that women are not sexually active throughout the entire reproductive period. It is assumed that the number of women of reproductive age married or living with someone determines the proportion of women in a society exposed to the risk of becoming pregnant. The greater the number of women exposed, the higher is the resulting fertility.

The index is calculated as the sum of age-specific proportions married, m(a), times age-specific marital fertility rates, g(a), divided by the sum of age-specific marital fertility rates:

$$Cm = \{\Sigma\, m(a) * g(a)\} / \Sigma\, g(a) \quad (2)$$

The index is often approximated by the proportion of women 15-49 that are married.

Ci: Index of Postpartum Infecundability: The index of postpartum infecundability is intended to describe the effects of extended periods of postpartum amenorrhea on fertility.

The index is calculated as the average birth interval in the absence of breast feeding divided by the average length in the presence of breastfeeding:

$$Ci = 20/(18.5 + i) \quad (3)$$

Where
I = average duration of postpartum amenorrhea

Index of Abortion: The index of abortion is intended to describe the fertility-inhibiting effects of induced abortion. The equation for the index is calculated by recognizing that each abortion will avert somewhat less than one birth because it also shortens the interval between potential pregnancies. The equation is:

$$Ca = TFR / \{ TFR + 0.4 * (1 + u) * TAR \} \quad (4)$$

Where u is contraceptive prevalence and TAR is the total abortion rate.

Index of Sterility: The index of pathological sterility is intended to estimate the fertility-inhibiting effects of primary and secondary sterility. Since data on sterility were scarce at the time, Bongaarts developed an equation to estimate the index as a function of primary sterility. The equation is:

$$Cp = (7.63 - 0.11 * s) / 7.3 \quad (5)$$

Where s is the percentage of women aged 45-49 who have had no live births. This equation is equal to 1.0 when three percent of women are childless at age 45-49. Anything above this level is assumed to be the effect of pathological sterility.

Index of Contraception: The index of contraception is intended to describe the fertility-inhibiting effects of contraceptive use.

The index of contraception was specified by Bongaarts to be:

$$Cc = 1 - 1.08 * u * e \quad (6)$$

Where u is contraceptive prevalence among married women and e is the average effectiveness of contraception. The adjustment factor 1.08 is designed to remove infecund women from the equation, so that the contraceptive index would become zero if effective prevalence reached 92.5 percent (the remaining women are assumed to be infecund).

Total Fecundity: Total fecundity is the total fertility rate in the absence of the fertility-inhibiting effects of the proximate determinants.

The main concept in our analysis is that reduction of TFR at the national level will be achieved by reducing it at regional level each region will have different contribution to the target level, this contribution will be determine according to their weights which is again will be determine by assessing these regions according to specific criteria which was selected as most important criteria affecting TFR in such community.

Proposed Decision Support Model: The Proposed model is divided into five main steps. The first step consists of identify criteria that affect TFR that plays a role in its reduction. In the second step each expert will determine the importance of each criterion with respect to other criteria. Then the collected real data from latest census and reliable surveys are assessed by experts for each governorate according to previously determined criteria, following that, the weight of each governorate at each region which is reflecting its contribution in the TFR reduction will be calculated. In the last step, Bongaart's model where the TFR can be calculated and applied to obtain targeted total fertility rate at regional level. And The AHP is applied a multi-criteria decision-making method to convert these experts' ratings into overall weights for the regions. AHP recognizes and incorporates the knowledge and expertise of the participants and uses it for pair-wise comparison of all relevant decision criteria and alternatives in order to find the best alternative that meets the objective. Once the hierarchy of the regional targets of TFR is established, the assessment will take place. Figure 1, shows the hierarchy of disaggregate target total fertility rate, that needs to be achieved should be disaggregated to levels from the national level to regional level and then to governorate level. In this paper we will discuss the disaggregated to governorate level.

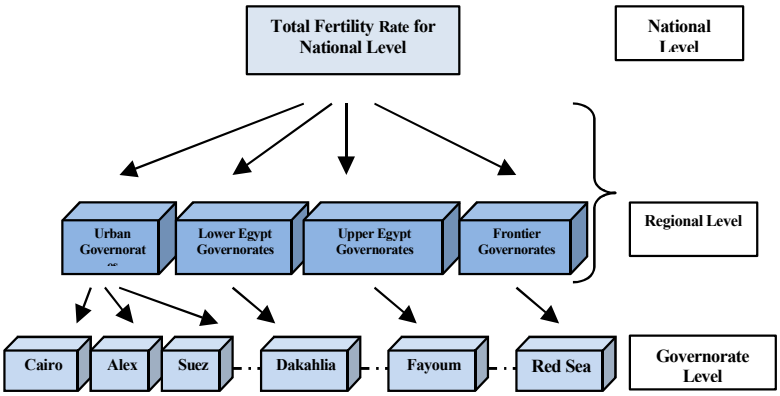


Fig. 1: The Hierarchy of Total Fertility Rate

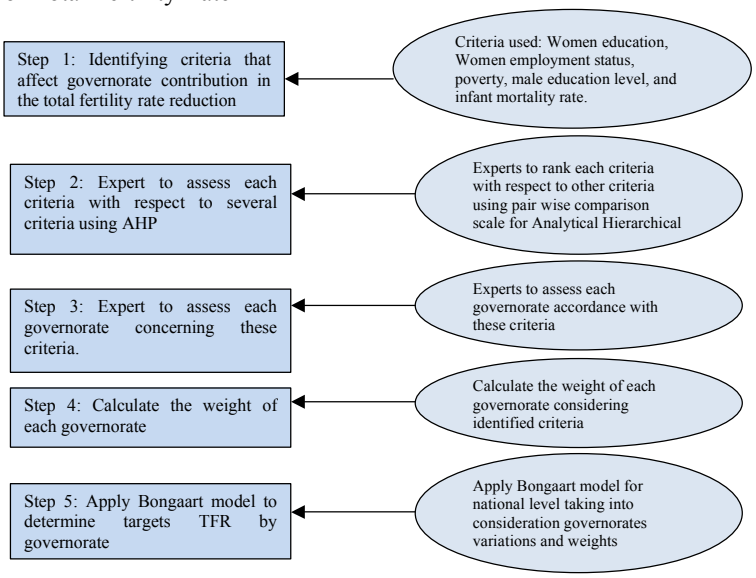


Fig. 2: Steps for calculating target TFR for each governorate

Figure 2, Shows the architecture of the proposed model and the main steps is described as:

Step1: Identifying criteria that affect region contribution in the total fertility rate reduction: in this step concerned in identified criteria used: Women education, Women employment status, place of residence, family income and spouse education level.

Step 2: Expert to assess each criteria with respect to several criteria using AHP: in this step Experts are interacted to give his preference to rank each criteria with respect to other criteria using pairwise comparison scale for Analytical Hierarchical Process.

Step 3: Expert to assess each region concerning selected criteria. In this step experts assess each region in accordance with criteria used in each region

Step 4: Calculate the weight of each region: this step concerned with calculating the weight of each region considering the identified criteria.

Step 5: Apply weighted - Bongaart model to determine targets TFR by region: this step is concerned with apply weighted Bongaart model for national level taking into consideration regions variations and weights

Implementation: Case of Egypt' Governorates: The proposed approach is implemented to reduce the national target TFR level of Egypt through reducing the TFR at governorate level as follows:

Step 1: Identifying Criteria That Affect Governorate Contribution in the Regional Fertility Rate Reduction: While several factors may have changed the overall fertility pattern, the impact on the fertility behavior of

individual women will depend on their particular circumstances and life transitions [3]. According to findings from the literature review about socioeconomic variables that effecting fertility [4] reduction and discussion with experts we were able to identify variables to be used in our analysis: women education, women employment status, poverty, male education level and infant mortality rate, previously mentioned five variables will be the considered while developing the required matrix to apply AHP.

Variable (1): Women Education: International surveys showed that there is relationship between women's education and total fertility rate. Evidence from several studies showed that a 10 per cent increase in the female literacy rate seems to be associated with a 0.5 decline in total fertility rate [5]. Education affects the supply of children through four intervening variables [6]. These are: (1) age at marriage; (2) breast feeding; (3) post-partum abstinence; and (4) child mortality. For *Age at Marriage*: education tends to increase the age at first marriage, thereby decreasing the number of years that can be devoted to child bearing [7]. *Breast Feeding*: Prolonged breast-feeding is one of the traditional practices that serve as a means of contraception. With increases in the levels of education of women, the period of breast-feeding tends to decrease. In regard to *Post-Partum Abstinence:* Women's compliance to the traditional norms that encourage prolonged post-partum abstinence tends to decline with increases in the levels of female education [8]. *Child Mortality*: High rates of child mortality reduce the supply of children, which in turn is likely to increase the demand for children. The existence of a linear relationship between mother's education and child mortality has been well established [9]. Findings from Egypt Demographic Health Survey demonstrated that, TFR decreases with rising levels of education; total fertility rate of the women at least secondary completed education is less than that of the no educated women.

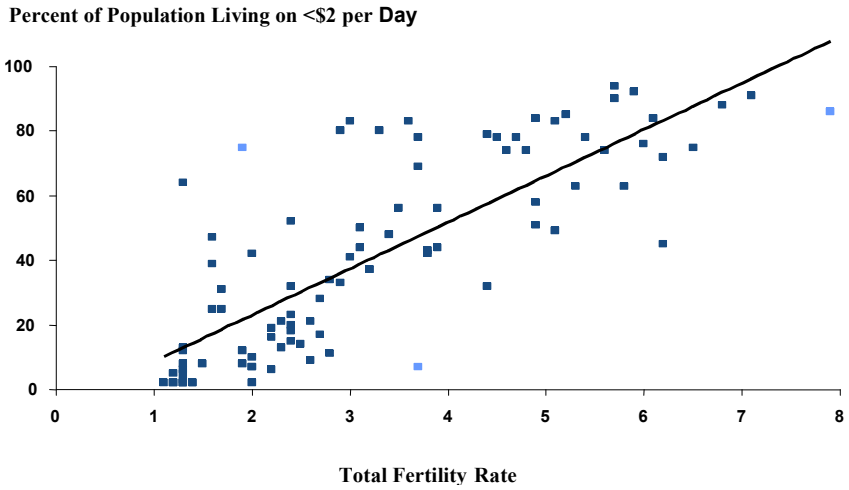
Variable (2): Women Employment Status: Fertility levels in developing countries are strongly influenced by the status of women, as measured by levels of education, paid employment and female infant mortality rate (a proxy for health care). Fertility can be reduced through the implementation of policies that enhance women's access to education and paid employment [10]. Women's economic activity rate is the variable most often used in demographic analyses of women's status.

In Egypt women's labor force participation rates have risen on 3.9 percent in the past 20 years, from 35.5 to 39.5 percent. Almost 80 percent of all employed women work including librarians, health technicians, secretaries, typists, teachers and child care workers [11]. Percentage of women in the labor force is directly related to total fertility rate [12]. The participation of females in the labor force is negatively related to fertility rate for many reasons [13]. Female employment outside the home is related to forming small families, working women tend to have fewer children than those who do not work because employment entails alternative satisfaction to children [14]. Labor Force is negatively related to Fertility. The elasticity of the fertility rate is around negative 0.5 (-0.5), suggesting that a 1% increase in female participation rate reduced fertility by 0.5% [15]. In our study we will consider women who are working for cash or doing their own business as the variable to be used in our analysis.

Variable (3): Infant Mortality Rate: Infant mortality, corresponding to deaths within the first year of life, is one of the major health and socioeconomic problems of our time. The literature review findings shows that high IMRs may also have an effect on birth rates; a family may tend to have more children for fear that some of these children may suffer death at early ages. [16].

A study done about the cross-national variation in total fertility rate [17] using principal component regression technique with national data for 43 developing countries shows that infant mortality rate has an effect on total fertility rate -the higher is the infant mortality rate the higher is the fertility rate. Many studies have obtained results supportive of the positive effect of infant and child mortality on fertility (Adlakha, 1973; Taylor, Newman and Kelly, 1976). The idea is conceptually related to the child survival hypothesis. Experience with, or fear of infant and child mortality might make married couples have 'extra' births to replace young children who already died. Another possibility is that couples might adopt modern contraception only when they are confident their fertility goal will be reached and not eroded by child mortality. As such, societies with higher infant mortality tend to have higher fertility.

Variable (4): Poverty and GDP per Capita: Literature review showed that a one per cent increase in GDP per capita was found to decrease the total fertility rate by between 0.17 and 0.31 per cent [18].



Source: Population Source: Population Reference Bureau, *Population & Economic Development Linkages* 2007 *Data Sheet*

Fig. 3: Association between Fertility and Poverty

In addition, it showed that low TFR strongly related to the economical factors, society modernization and liberalization highly economical developed countries with more than 10100 GDP per capita ($) have TFR decline. TFR depends on the disposable expenses and expected usefulness of the children. To uphold the thesis he gives an example of the rural family that used to have more children in order to assure help for maintaining the family. Human resources were urgent for working on the fields, in the woods, etc. Nowadays, agriculture has become more and more automated, thus reducing the need for human forces. Consequently, the cost benefit of the children dropped drastically and families began to shrink. Besides, factors like higher educational level, lower child mortality rate and the desire for career making among young people, pushes TFR even lower [19].

As shown in Figure 3 the highest percent of poor people the highest of total fertility rate[20].

Many studies showed that fertility is often higher in poorer families within a society and across countries those with higher average fertility tend to have lower average income. Do these associations imply that high fertility causes poverty among family members, or that poverty contributes to higher fertility, or both? Is the direct association between fertility and poverty a basis for assessing the value of policy interventions that reduce fertility by subsidizing the voluntary adoption of birth control, or by imposing on parents a quota of children which penalizes excess births, such as implemented by China?

It is hypothesized in this essay that some sources of family income encourage and other sources discourage, fertility, because different sources of family income modify the economic opportunities parents must sacrifice to have another child, or the price of children in terms of parental time and market goods [21].

Variable (5): Male Education Level: A husband's demand for children is significantly related to his wife's desired fertility, as well as to the couple's fertility outcome. An improved husband-wife educational level results in greater reproductive autonomy of the women and an increased use of contraception [22]. TFR according to spouse education was not available at governorate level, so using male 10+ education level were used to reflect same impact on the TFR.

Step 2: Expert to Assess Each Criteria with Respect to Several Criteria Using AHP: In this step each expert will assess the criteria with respect to several criteria using AHP, experts were consulted during this phase by asking them to give each variable a score with respect to other variables according to previously mentioned ranks [23] in Table 1.

Putting expert opinions in a matrix and apply AHP technique by calculating Eigen value [24], CI and CR and ensure that it is less than 0.1 for consistency. After obtaining the five expert assessments we were able to develop a summary matrix that summarize their opinions and apply required calculation to obtain Eigen value and CI, CR.

Table 1: Summary of Five Experts Opinions on Assessing the Selected Criteria

Summary of experts	Women Education	Women employment status	Infant Mortality Rate	Poverty	Male Education level	Geometric Mean	Normalized Score
Women Education	1	3	3.8	3.2	3	2.672	0.426
Women employment status	0.367	1	3.6	0.383	2.8	0.971	0.155
Infant Mortality Rate	0.297	0.283	1	0.340	2.2	0.445	0.071
Poverty	0.317	2.8	3.2	1	3.4	1.547	0.247
Male Education level	0.350	0.367	0.467	0.307	1.000	0.636	0.101
λmax= 5.5498	CI= (λmax -n)/n-1= 0.137			RI = 1.12		CR=CI/RI = 0.123	

By reviewing the overall experts assessment of selected criteria and taking the average of their rating of each criterion in respect to other criterion, we find that as shown in Table 1, each expert assessed the criterion the summary of their assessments shows that women education level is moderately important in respect to women employment status, male education level and poverty. Infant mortality rate is equally to moderately important in respect to male education, poverty is moderate to strongly important in respect to male education level. Poverty ranked as equally to moderately important in respect to women employment status and moderately to strongly important in respect to infant mortality rate. Final conclusion of ranks showed that women education is the most important criterion, then poverty, followed by women employment status, male education and infant mortality rate came as less important than other criteria.

By obtaining CR = 0.123 which is = 0.1 proof that the matrix is consistent and can be utilized to calculate the weight of each governorate in target total fertility rate.

Step 3: Experts Assessments for Each Governorate in Urban Region Concerning Selected Criteria: To determine each governorate contribution in total fertility reduction, experts will rank governorates according to previously mentioned variables which were selected to affect total fertility rate. Data used were obtained from reliable resource for that type of information which is the census that is conducted each 10 years, the latest one for 2006.

The First Criterion: Women Educational Level.

Rule: The governorate which women have high percentages of non educated women will be more important for family planning program and will be in need for more efforts to achieve that. To analyze such data, we summarized it in four categories, which are women with no education as it is illiterate women, read and write category to show women with little education, then less than secondary which include women who have primary education and less than secondary, the last category is for secondary and above which include women who completed secondary and university and above. Table (2) shows the demonstrate percent of female 10+ by educational level, that was calculated from the most updated reliable source for such information which is 2006 census by CAPMAS.

As shown in Table 2 at Urban Governorate Region, the highest percent of illiterate women is in Cairo, around quarter of women aged 10+ doesn't have any education and around half of them are educated secondary and above. While the highest level of women who are educated to the secondary level or higher are living in Port-Said.

As shown in Table 3 for Urban region, assessing governorates considering women education level demonstrate that Cairo is moderately important in respect to Port-Said and Suez Alexandria is moderately important in respect to Suez. Suez rated as equally to moderately important in respect to Port-Said. When considering women education level, Cairo is the most important governorate to emphasize family planning program on, followed by Alexandria, Suez and Port-Said.

By obtaining CR = 0.08 < 0.1, proof that the matrix is almost consistent and can be utilized.

The Second Criterion: Women employment status

Rule: The governorate which have high employment rate among women will be more likely to increase its contraceptive prevalence rate and accordingly reduce TFR, but also we need to consider cash payment in the assessing. So we will need to focus more on governorates which have low female employment participation rate and lower percent of paid employee among women labor force. To discuss women contribution in labor force, as well as women who are working for cash, we collected data from census as shown in Table (4).

According to Table 4 the highest percent of women in labor force is among Port-Said' women, while the lowest is in Cairo. If we emphasize on who are paid as this make women more committed we found that the highest is among women in Port-Said, while the lowest in Alexandria.

Table 2: % of Women 10+ by education at Urban Governorate Region, 2006

	No education	Read & Write	Less than Secondary	Secondary and Above
Cairo	24.697	9.343	19.219	46.741
Alexandria	23.484	11.225	21.691	43.599
Port-Said	19.536	11.528	16.821	52.115
Suez	21.714	13.183	20.566	44.537

Table 3: Assessment of Urban Region Governorates Considering Women Education Level

Summary	Cairo	Alexandria	Port-Said	Suez	Geometric Mean	Normalized Score
Cairo	1	2.6	3.4	3.4	1.975	0.435
Alexandria	0.4	1	2.4	3.4	1.267	0.279
Port-Said	0.3	0.433	1	0.433	0.562	0.124
Suez	0.3	0.3	2.4	1	0.736	0.162
λmax= 4.22	CI= (λmax -n)/n-1 = 0.073		RI= 0.9	CR=CI/RI = 0.082		

Table 4: Women Employment Status at Urban Governorate Region, 2006

Governorate	% of women in Labor force	% of paid employee among women labor force
Cairo	11.9	89.2
Alexandria	21.7	53.4
Port-Said	24.8	94.3
Suez	22.1	74.2

Table 5: Assessment of Urban Region Governorates Considering Women Employment Status

Summary	Cairo	Alexandria	Port-Said	Suez	Geometric Mean	Normalized Score
Cairo	1.0	5.0	7.4	6.6	3.000	0.569
Alexandria	0.203	1.0	4.0	2.2	1.123	0.213
Port-Said	0.137	0.263	1.0	0.6	0.464	0.088
Suez	0.152	0.533	1.8	1.0	0.681	0.129
λmax= 4.168	CI= (λmax -n)/n-1 = 0.055		RI= 0.9	CR=CI/RI =0.062		

As shown in Table 5, For Urban region, for women employment status Cairo governorate ranked as strong important in respect to Alexandria and to very strong in respect to Suez and also it was ranked as demonstrated to absolute important in respect to Port-Said. Alexandria were classified as equal to weak important in respect to Port Said. Suez and Port-Said ranked as equal important. By obtaining CR = 0.007 which is = 0.1 proof that the matrix is consistent and can be utilized to calculate the weight of each governorate for Urban region in target total fertility rate. In addition, we can conclude from Table (5) that considering women employment status Cairo is the most important governorate to focus on, followed by Alexandria, Suez, then Port-Said.

The Third Criterion: Infant Mortality Rate

Rule: The used rule concerning this criterion is that the governorate which has high Infant Mortality Rate needs to reduce its total fertility. Infant mortality rate and Maternal Mortality Rate is reflecting health status of the community. As mentioned before, communities with high Infant Mortality Rate will be targeted by program managers to reduce its fertility rate

For Urban region as shown in Table 6, the highest Infant Mortality Rate is at Cairo, while the lowest in Suez, the highest Maternal Mortality Rate is among Alexandria women and the lowest among Port-Said women.

As Table 7 shows experts assessment for Urban governorates considering Infant Mortality rate find Port-Said moderately to strongly important in respect to Alexandria, Cairo rated as strongly important in respect to Alexandria and very strong to extremely important in respect to Suez. In addition, Port-Said rated as strongly important in respect to Suez. Alexandria rated as moderate to strongly important in respect to Suez.

Table 7 demonstrate that Urban region governorates ranked according to infant mortality rate as Cairo most important governorate to focus family planning program to reduce its fertility, followed by Port-Said, then Alexandria and finally Suez governorate.

Table 6: Infant Mortality Rate and Maternal Mortality Rate, 2008

Governorate	Infant Mortality Rate	Maternal Mortality Rate
Cairo	29.5	53
Alexandria	19.7	70
Port-Said	23.4	42
Suez	14.7	56

Table 7: Assessment of Urban Region Governorates Considering Infant Mortality Rate

Summary	Cairo	Alexandria	Port-Said	Suez	Geometric Mean	Normalized Score
Cairo	1	5.2	3.6	7.2	2.666	0.516
Alexandria	0.197	1	0.333	4.2	0.773	0.149
Port-Said	0.283	3.2	1	5.2	1.364	0.264
Suez	0.140	0.247	0.197	1	0.369	0.071
λmax= 4.269	CI= (λmax -n)/n-1 = 0.0898		RI= 0.9	CR=CI/RI= 0.099		

Table 8: % of Poor Population and GDP per Capita by Governorates, 2008

Governorate	% of poor from population	GDP per capita
Cairo	7.66	7726.4
Alexandria	6.4	8978.3
Port-Said	4.4	10549.7
Suez	1.9	8745.8

The Fourth Criterion: Poverty

Rule: The used rule concerning this criterion is that the governorate which has high percent of poorest need more focus to reduce its total fertility rate. Percent of population who are poor is reflecting standard of living at the governorate, in addition GDP per capita shows the governorate standard of living.

As shown in Table 8, the lowest percent of poor population in Suez, the highest in Cairo. The highest GDP per capita is for Port-Said Population, followed by Alexandria and Suez, the lowest level of GDP is for Cairo.

As shown in Table 9, summary of experts assessment shows that Alexandria is moderately important in respect to Port-Said, while it was rated as strong to very strongly important in respect to Suez, Port-Said is rated as moderate to strongly important in respect to Suez. Cairo rated as very strongly important in respect to Suez, Cairo also rated as strongly important to Port-Said and moderate to strongly important in respect to Alexandria. In summary, Cairo was rated as most important governorate, followed by Alexandria, Port-Said and Suez.

The consistency ration is 0.101 which is = 0.1 reflect that the summary of experts assessment matrix is consistent and can be used to calculate governorate contribution in the regional reduction of TFR.

The Fifth Criterion: Male Education Level

Rule: The used rule concerning this criterion is that the governorate which has high non educated male need strong programs to reduce its total fertility rate. Data about education was classified same as women education criteria, illiteracy, read & write, less than Secondary and Secondary and above.

Table 10 shows % of male in age 10+ by educational level in Urban region, the highest percent of illiteracy is among males in Cairo, while the highest percent of males who are educated to secondary and above is among males in Port-Said.

As shown in Table 11 considering male education level experts' opinions reflecting that in general all governorates are in moderately important in respect to each other.

Step 4: Calculate the Weight Assessment of Each Governorate by Region Considering Identified Criteria: After obtaining the assessments of each criterion and then assessing each governorate according to such criterion. We will go through each governorate to obtain each governorate contribution in targeted total fertility rate (TFR)

The overall assessment of Urban region' governorates is shown in Table 12.

Then we can obtain the vector of weight for each governorate by applying the AHP technique using data of Table 1 and normalized scores of Tables 3, 5, 7, 9,11 as follows:

$W_i = \Sigma$ Normalize score for $criteria_q$ X Normalize score for $governorate_i$ for $criteria_q$

Table 9: Assessment of Urban Region Governorates Considering Poverty

Summary	Cairo	Alexandria	Port-Said	Suez	Geometric Mean	Normalized Score
Cairo	1	3.6	5	7.6	2.674	0.510
Alexandria	0.283	1	3.8	6.6	1.48	0.282
Port-Said	0.207	0.267	1	4	0.739	0.141
Suez	0.132	0.152	0.257	1	0.349	0.066
λmax= 4.272	CI= (λmax -n)/n-1 = 0.091		RI= 0.9	CR=CI/RI = 0.101		

Table 10: % of 10+ male by Educational Level at Governorates, 2006

Governorate	Illeteracy	Read&write	Less than Secondary	Secondary and Above
Cairo	16.074	10.174	20.719	53.033
Alexandria	15.615	12.695	23.327	48.362
Port-Said	13.346	12.886	18.447	55.321
Suez	12.726	14.488	22.360	50.426

Table 11: Assessment of Urban Region Governorates Considering Male Educational Level

Summary	Cairo	Alexandria	Port-Said	Suez	Geometric Mean	Normalized Score
Cairo	1	1.8	3	2.4	1.669	0.375
Alexandria	0.667	1	2.2	3	1.345	0.302
Port-Said	0.350	0.467	1	2	0.799	0.179
Suez	0.433	0.433	0.567	1	0.639	0.143
λmax= 4.267	CI= (λmax -n)/n-1 = 0.089		RI=0.9	CR=CI/RI= 0.099		

Table 12: Calculation of governorate Weights

Calculated Normalized Scores	Women Education	Women Employment	Infant Mortality Rate	Poverty	Male Education Level
Criteria assessments	0.426	0.155	0.071	0.247	0.101
Cairo	0.435	0.071	0.516	0.510	0.375
Alexandria	0.279	0.205	0.149	0.282	0.302
Port-Said	0.124	0.454	0.264	0.141	0.179
Suez	0.162	0.270	0.071	0.066	0.143

Cairo Weight = 0.426 X 0.435 + 0.155 X 0.071 + 0.071 X 0.516 + 0.247 X 0.510 + 0.101 X 0.375 = 0.39680579 ≅ 0.397

Alexandria Weight = 0.426 X 0.279 + 0.155 X 0.205 + 0.071 X 0.149 + 0.247 X 0.282 + 0.101 X 0.302 = 0.26152721 ≅ 0.261

Port-Said Weight = 0.426 X 0.124 + 0.155 X 0.454 + 0.071 X 0.264 + 0.247 X 0.141 + 0.101 X 0.179 = 0.19471933 ≅ 0.195

Suez Weight == 0.426 X 0.162 + 0.155 X 0.270 + 0.071 X 0.71+0.247 X 0.066+0.101 X 0.143 =0.14694766 ≅ 0.147

Step 5: Apply Weighted-bongaart Model to Obtain National Targets Tfr Rate by Governorate: To calculate target total fertility rate concerning contribution of each governorate we will need to set up constraints for Bongaart function, to do that we will need to calculate limits for each variable of Bongaart function (upper limit and lower limit), to do that we will consider one limit is the current state of the variable and the other limit will be what can be achieved or need to be achieved to reduce fertility which can be done through adopting policies and/or doing efforts that will help to achieve such targets, in many times we will set up hypothesis assumptions for potential targets for each of Bongaart variables.

$TFR = Cm * Ci * Ca * Cp * Cc * TF,$ Where:

Cm : is the index of proportion married, Ci: is the index of lactation infecundability, Ca : is the index of abortion, Cp: is the index of pathological sterility, Cc : is the index of contraception and TF : is total fecundity.

The weighted for each governorate in Urban Governorate region function is defined as:

For each governorate Min $TFR = \Sigma\, w_i\, (Cm * Ci * Ca * Cp * Cc * TF)_i$

$= w_{gov1}\,(Cm_{gov1} * Ci_{gov1} * Ca_{gov1} * Cp * \mathrm{Cc}_{gov1} * TF)$
$+ w_{gov2}(Cm_{gov2} * Ci_{gov2} * Ca_{gov2} * Cp * \mathrm{Cc}_{gov2} * TF)$
$+ w_{gov3}\,(Cm_{gov3} * Ci_{gov3} * Ca_{gov3} * Cp * \mathrm{Cc}_{gov3} * TF)$
$+ w_{gov4}\,(Cm_{gov4} * Ci_{gov4} * Ca_{gov4} * Cp * \mathrm{Cc}_{gov4} * TF)$….etc

Table 13: Summary of Constraints for Total Fertility Function at Urban Governorate Region

Governorate	Cm	Ci	Ca	Cp	Cc	TF
Cairo	0.554 < Cm < 0.604	0.885 < Ci < 0.926	0.884	0.893	0.268 < Cc < 0.327	15.3
Alexandria	0.564 < Cm < 0.614	0.885 < Ci < 0.926	0.880	0.893	0.301 < Cc < 0.360	
Port-Said	0.564 < Cm < 0.614	0.885 < Ci < 0.926	0.887	0.893	0.396 < Cc < 0.455	
Suez	0.576 < Cm < 0.626	0.885 < Ci < 0.926	0.899	0.893	0.277 < Cc < 0.336	

Table 14: Target level with contribution of each governorate

Governorate	Weights	Current Fertility Level	Target Fertility Level
Cairo	0.397	2.212	1.587
Alexandria	0.262	2.466	1.809
Port-Said	0.195	3.138	2.399
Suez	0.147	2.394	1.732

Where i =1,2,3,4,…n which are the governorates at this governorate

Min *TFR*

$$= 0.39680579 \left(Cm_{cairo} * Ci_{cairo} * Ca_{cairo} * Cp * Cc_{cairo} * 15.3 \right)$$
$$+ 0.26152721 \left(Cm_{Alex} * Ci_{Alex} * Ca_{Alex} * Cp * Cc_{Alex} * 15.3 \right)$$
$$+ 0.19471933 \left(Cm_{Port\text{-}Said} * Ci_{Port\text{-}Said} * Ca_{Port\text{-}Said} * Cp * Cc_{Port\text{-}Said} * 15.3 \right)$$
$$+ 0.14694766 \left(Cm_{Suez} * Ci_{Suez} * Ca_{Suez} * Cp * Cc_{Suez} * 15.3 \right)$$

A summary of calculated Bongaart' variables is shown in Table 13.

A summary of total fertility rate functions at each governorate with the constraints according to variables at Urban region. Finally by using the information of Table 13, total fertility rate is calculated at both current level and target level with contribution of each governorate as showed in Table 14.

Conclusion and Further Research: In this paper, we proposed a decision support model to determine the contribution of urban region in the National target TFR using analytical hierarchical Process (AHP). The proposed model provides an aid that supports in identifying the suitable policy for regional sustainability developing regarding family planning programs. By determining and reducing the contribution of each governorate in Urban region of TFR and its fertility rate to achieve the national target TFR taking into consideration its socio-economic context including women education level, percent of young women, infant mortality, age at first marriage, women working status, spouse level of education, family income and place of residence. The AHP is employed to assess the contribution of each governorate in the regional target TFR according to experts assessment of five criteria to determine the most important and effective criterion within each governorate. These criteria include women educational level, women employment status, infant mortality, poverty and male education level. The proposed approach is implemented in Egypt as a real case. The obtained results showed that the proposed approach performed well in achieving the reduced regional target level of TFR. In addition, it shows that Cairo and Alexandria Governorates need more focus from the family planning program to be able to reduce its fertility and achieve target TFR. For further research we intend to introduce more criteria such as younger women. Also, extend the proposed approach to determine the contribution of each governorate in Lower Egypt, Upper Egypt and Frontier regions to the national total fertility rate.

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