Economic Burden of Disease and Cost Benefit Analysis of Emergency Medical Service (EMS) System in Romania

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Abstract

The objective of the research is to provide an analytical model of the economic Cost-Benefit Analysis (CBA) and resultant policy recommendations, with the proposed emergency medical service (EMS) project in Constanta County (714,923 population, 2005), Romania, in view. The economic cost of investment is US$ 31.5 million as per 2006 price level. The economic benefits are due to (i) incremental benefits attributable to EMS at the Constanta Emergency Hospital (CEH) as measured by willingness to pay (WTP) for healthier life, and (ii) social cost-saved (recovery of Productivity foregone due to emergent injury and diseases) measured by disability-adjusted life years (DALY). WTP was estimated by Contingent Valuation Method (CVM)-Double-bounded Dichotomous Choice method (449 interviewees) resulting in US$ 1.6 million par annum (US$ 214.8 per household, 8.9 percent of average household disposable income in Constanta). DALY in Constanta in 2005 is estimated at 118,885 person-years while applying the "ratio method" of total DALY to death DALY (7,286 deceased) and the disability adjustment factors (weighed average 0.67). With his and the productive beneficiaries (age group 15-59) of EMS at CEH (5,812 DALY) and the annual household disposable income in Constanta average (US$2,420.7), financial-benefits-converted to the social cost-saved is US$ 12.7 million (SCF=0.9), totaling to US$ 14.3 million of economic benefit per year. The economic internal rate of return (EIRR) is 32.2 percent, thereby quantitatively revealing high economic viability (efficiency in scarce resource allocation) of the concerned EMS project in Constanta.

Keywords

Economic Cost Benefit Analysis (E-CBA), DALY, Willingness to Pay (WTP), Economic Internal Rate of Return (EIRR), Emergency Medical Service (EMS), Romania

1. Introduction

In 1997, Romania embarked on the health sector reform shifting from the centralized government financing and delivery of services to a more decentralized and pluralistic approach. In this light, the government introduced a compulsory health insurance fund, with 19 percent of gross wages and pensions being deducted. Yet the sector is facing a number of policy issues to be addressed, inclusive of the...
mismatch between demand and supply of qualified and enough emergency medical services (EMS) in local cities in particular. As pointed out by the World Bank, the policy issues now the Romanian health system confronts include, among others, the followings.

- Shortcomings in the efficiency, equity and transparency of sector financing,
- Inefficient use of physical capacity and human resources in health care delivery,
- Weaknesses in governance of the system and the legislative framework;
- Critical infrastructure deficiencies resulting from inadequate maintenance and investment; and
- Clients' dissatisfaction with and distrust on health services delivered.

In Constanta with the fourth largest population in the country, the Constanta Emergency Hospital (CEH) is the largest general hospital in Constanta County with 66,008 in- and out-patients (2005), accounting for 58.7 percent of the aggregate patients of 112,486. Of this, emergency service beneficiaries accounts for 33.5 percent in average. The objective of the proposed public intervention measure (the project) is to provide more accessible services with increased quality and quantity in a bid to maximize the health sector outcomes and impact for those requiring emergency medical services in the CEH, with around one-third of CEH patients. Specifically, the project is to (i) supply medical equipment urgently in need to the Emergency Department, (ii) train medical staff for the increased quality of patient care and survival rate of patients arriving at emergency room (ER), and (iii) upgrade the existing communication system of the County Directorate of Public Medical Pre-hospital Emergency Service enabling voice and data communication between the county ambulance dispatcher and sub-stations /ambulances. As depicted below (Fig.1), the share of public sector medical services in the Constanta County has recently been declined from above 70% in 2002 to less than 60% in 2005, with an increase in the use of private drug stores. This may reflect people's skepticism on the public health system and its service quality.

2. Objective and Rationale

The international financing institutions (World Bank and others) as well as academic institutes (Murray and Lopez, 1996, and Peabody J.W. et al. 2005) has since last decade endeavored to quantitatively analyze and estimate the value of life.
and healthy life in a logically consistent framework for analysis, while elaborating in tandem (proxy) measurement indices including the willingness-to-pay (WTP) and disability-adjusted life years (DALY). In this light, the objective of the research is to provide an analytical model of the economic Cost-Benefit Analysis (CBA) and resultant policy recommendations, while undertaking the quantitative analysis of the proposed emergency medical service (EMS) project in Constanta County, Romania. This research work is most likely the very first academic venture applied to Romania and other transition economies with a rigid framework of cost-benefit analysis (CBA) and the economic viability index (EIRR) based on the methodological research works on site. In tandem, the output of this task is used for substantial feedback, as a policy analysis and recommendations, to the government and policy makers in the light of efficient allocation of scarce resources in the country.

3. Methodology

3.1 CBA and EIRR analysis

The economic internal rate of return (EIRR) analysis takes place herewith where economic viability of the Project is quantitatively measured by EIRR and the economic net present value (ENPV), based on the estimated economic cost and benefit streams laid down over the project period. Financial costs are converted to economic costs in real term to reflect the true value of goods and services employed during the project period. Economic benefits are quantifiably valued in monetary terms by WTP for health and DALY.

3.1.1 Direct and indirect benefits

Health sector projects would generate a diverse set of benefits inclusive of productivity gained due to a fewer life years lost to mortality and morbidity, consumption gains due to a higher quality of life and increased life expectancy, and cost savings on curative treatments. Nonetheless, in line with what has commonly been in place, the economic benefits in this research is strictly confined to the productivity impact, thereby treating only the production side of the health effects, while eradicating the consumption side.

3.1.2 “With” and “Without” — Project principle

The economic benefits in the framework of “with” and “without” the project as elucidated in the above is depicted and given in Fig.2.

3.1.3 Transfer payments

Transfer payment means a shift of claims on real resources from one member or sector of society to

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**Figure 2** Schematic diagram of “with” and “without” project
another without causing any depletion of scarce resources in the society. With this in view and acquisition, interest payments, domestic taxes and duties are eradicated from financial costs in due course of the estimation of economic costs.

3.2 Long-Run Marginal Cost (LRMC) pricing

The economic value of scarce resources used as project inputs is measured by the Long-Run Marginal Cost (LRMC) pricing method. Underlying assumption of this method is that economic benefit of investment measures is maximized when the price (benefit) is identical to the marginal cost under the assumptive "perfect competitive market". The origins of marginal cost pricing theory date back as far as the works of P. Dupuit and subsequently H. Hotelling, in the 1930's. N. Ruggles provided a comprehensive review of work in this area up to the next decade, and the theory developed, especially for the application of in the electric power sector, with contributions from the works of M. Boiteux, P. Steiner and others from the 1950s and onwards. More recently, the academic interest has led to more sophisticated investment models which permit determination of marginal costs, consideration of uncertainty, developments in peak load pricing, and so forth. On the practitioner's side, a number of contributions have been made by the economists of the international lending agencies, namely, M. Munasinghe, J. Warford, Y. Albouy, and others. Backed up by these and others, the rationale for setting price equal to marginal cost to consequently attain the maximum economic welfare level is briefed herewith.

The rational for setting price equal to marginal cost may be clarified in mathematical terms as follows:

\[ \frac{d}{dQ} NET = \frac{p}{Q} + p \cdot \frac{\delta TC}{\delta Q} \]

Now, the price elasticity of supply denoted as \( \epsilon \) is defined that \( \epsilon = \frac{\partial Q}{\partial p} \times \left( \frac{p}{Q} \right) \). Sequentially the above equation is rewritten as below.

\[ \frac{1}{\left( \frac{\partial Q}{\partial p} \times \left( \frac{p}{Q} \right) \right)} \left( \frac{p}{Q} + p \cdot \frac{\delta TC}{\delta Q} \right) \]

Provided that \( \epsilon = \infty \) under the assumption of perfectly competitive market,

\[ p = \frac{\delta TC}{\delta Q} = \text{Marginal Cost} \]

It is one of the basic axioms of economics that at the price \( p \) and supply (demand) \( Q \), the total net benefit of consumption attributed to society is maximized with the optimum market clearing point \( (p, Q) \).

3.3 Economic costing and SCF

As for the foreign cost portion of the project, this procedure is reflected by way of valuating goods and services in, notably, CIF (Cost of Insurance and Fleet) and FOB (Fare on Board) prices, respectively. Likewise, the local cost portion of the project, a standard conversion factor (SCF) usually is applied to convert market value of local costs to its value in shadow prices. While SCF requires information on the ratios of border prices to market prices for a variety of commodities, it can be approximated by the use of data on foreign trade and net border taxes of general commodities. The approximation is provided by the border value formula as follows.

\[ SCF = \frac{M+X}{(M+t_m)(X+t_s)} \]

where \( M \) and \( X \) denote the value of imports and exports in border prices, respectively, where \( t_m \) is
import duties net of subsidies and $t_4$ is export duties net of subsidies.

In the light of EIRR analysis, the economic cost stream as per constant 2006 price level includes (i) capital cost of public intervention, and (ii) associated operation and maintenance (OM) costs for the economic life (project life) of the EMS section at CEH at a required level over the period of 2007 through 2027. To note that the estimation excluded the costs incurred prior to the afore-mentioned years as sunk costs.

3.4 Economic benefits

The economic benefits are due to (i) incremental EMS as measured by willingness to pay (WTP) for healthier life, and (ii) social cost-saved (recovery of foregone benefit) as measured by disability-adjusted life years (DALY).

3.4.1 Incremental benefit-willingness to pay

3.4.1.1 Sampling methodology

WTP is coherently defined as people’s perceptive “bid prices” at the highest level for the service to be rendered, or “proxy measurement” of economic value. Beneficiaries (research population) in 10 cities and communities on the Black Seashore area is set at around 421,000 (58.9% of the total) in Constanta County. In carrying out the research, the double-bound dichotomous choice method of the Contingent Valuation Method (CVM) approach was applied to the interview survey.

449 residents and visitors were randomly-selected from the three categories of (i) households, (ii) business entities (commercial, industrial, and services), and (iii) beach resort visitors (expatriates and domestic travelers/residents), with the random selection procedure. It would be stressed that the sampling methodology aimed at taking into account both of the people perceiving Use-Value (needs EMS) and Non Use-Value (not necessary in need of EMS now, but psychologically felt safer by the existence of EMS of avail). CVM 2002 was used as software for statistical analysis of WTP estimation, while utilizing Microsoft EXCEL to undertake a double-folded analysis.

3.4.1.2 Design of interview survey and questionnaire

Beneficiary area due to the Project includes four (4) cities and six (6) communities; the cities of Constanta, Mangalia, Navodari, and Eforie (North and South), and the communities of Corbu, Agigea, Tuzla, Costinesti, 23 August, and Limanu. Of this, the shares of interviewees amongst households, beach resort visitors, and business entities counted for 55 percent, 30 percent, and 15 percent in that order, while taking the number of the units in the Constanta County in view. With this, the actual sampling size turned out to be 250, 140, and 70 (all figures somewhat rounded) in the same order. Subsequently, all these sample figures are allocated to each of the four cities and six communities in proportion to the number of population therein. Population distribution and the sample size for each of the target cities and communities are summarized and depicted in the following Table 1.

Meanwhile, bidding games in the current research used the five-version-cascading structure, with the middle bidding price of US$17.1 per household per month (8.0 percent of household disposable income in Romania in 2005. Neighboring bidding rates are from the lowest share of disposable income 3.0 percent (US$ 6.4), 5.0 percent (US$ 10.7), 8.0 percent (US$ 17.1), 10.0 percent (US$ 21.4), and 13.0 percent (US$ 32.1), in the ascending order. In due course of questionnaire designing, trial-basis interview survey with the Romanian counterpart team and Focus-group meeting with around 20 randomly-sampled participants tested the validity of the questionnaire, while modifying the questionnaire as appropriate.

3.4.2 Social cost saved-DALY

Initiated by the World Bank that sponsored the aspiring study on global burden of disease (GBD) in collaboration with the World Health Organization (WHO) and the Harvard School of Public Health, the
Disability Adjusted Life Years (DALY) has since 1993 been in a common place as an integrated measurement of population health (IMPH) for quantifying health burden. In the light of this, and as part of the economic benefits incurred (cost-saved portion) to the prospective intervention measure, economic burden of diseases and injuries in Constanta county is initially estimated by DALY and subsequently converted into monetary terms.

Central to the World Bank model in the estimation of DALY is the formula hereunder, with a set of parameters coherently applied to the four cases of quantity and quality of life. Some of the parameters and the constant are presumably set out including (i) age-weight modulation factor (K), (ii) constant (C), (iii) discount rate of life (r), (iv) age-weight (β), and (v) disability weights (D), with numerical expression as:

\[
DALY = \frac{KDCe^{-\rho}}{(\beta + \gamma)^{1-\rho}} \left[ e^{\mu(\beta + \gamma)(L+o)} - (1 + (\beta + \gamma)o) \right] = -\frac{e^{\mu(\beta + \gamma)(L+o)} - (1 + (\beta + \gamma)o)}{\gamma}
\]

In the light of the foregoing, prepositions in the current research are as follows.

(i) Standard life expectancy at birth by gender: Male at 80.0 of age and female at 82.5 of age, while assuming a standard life table for all populations;

(ii) Age-weighting: K is assumed to be one (1) in the current research in line with the researches previously undertaken in Romania (WB 1998), New Zealand (Ministry of Health 2001) and Australia (Ministry of Health 1999), as well as other WB documents on DALY;

(iii) Constant (C): presumably set at 0.16243;

(iv) Time discounting of healthy life (r): Three (3) percent of discount rate is assumed in line with the Global Burden of Disease (GBD) study\(^9\) and others;

(v) Parameter for age weighting function (β): Presumably set at 0.04;

(vi) Disability weights (D): Disability adjustment factors used in the World Bank model, with the weighed average of 0.67; and

(vii) \(e\): an exponential.
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With the above in view, the World Bank model of a "ratio method" of total DALY to death DALY was used with a set of disability adjustment factors based on the 2005 county mortality data collected from the National Statistic Office database and compiled by age group, gender, and residency (in aggregate 7,286 deceased). The human capital approach that uses loss of earnings (average household income) was applied to value social cost (benefit foregone). This provides the first order, lower-bound (conservative) estimates of foregone benefits comparing to the alternative approach to apply national income.

3.4.3 Allocative efficiency value—LRMC pricing

LRMC pricing, by mathematical definition, ensures the most efficient allocation of scarce resources, thus making the whole economy better-off. In estimation of LRMC-based price, the most commonly used variant of the theoretical concept in welfare economics and investment-decision theory is a levelized annuity cost coupled with recurrent cost incurred every year. In a bid to further estimate the annualized cost of investment, capital recovery factor (CRF), a function of (social) discount rate of capital (denoted by $i$) and economic life ($n$), will be applied in most of the places. Numerical expression of LRMC pricing comes in the following.

Annuited economic cost of capital investment (Marginal Cost) 

$$= TC \times CRF(i, n) + \text{annual economic OM cost},$$

where TC denotes the total capital investment cost, while CRF is depicted as:

$$CRF = \frac{i(1+i)^n}{(1+i)^n-1}$$

3.5 Model configuration for analysis

Subject to technical and data/information of avail, model configured and numerical assumptions are set forth with a number of variables and parameters specified are given in the followings.

(a) Project life: 18 years with the year 2007 to commence the 3-year construction works up to 2009 and the subsequent 15-year-service period to the year 2024;
(b) Foreign exchange quotation: Mid-2006 market value of the RON 2.8 per US dollar;
(c) Conversion factors: To avoid built-in market failures (non-competitive pricing, externality of the economy, etc.), the standard conversion factor (SCF) and that for unskilled labor are set at respective of 0.90 and 0.85;
(d) Physical contingency and price contingency: physical contingency allowances are set at 5.0 percent of the base cost while reflecting unexpected increases in cost by technical uncertainty. On account of inflationary pressure, price contingencies are assumed to be 2.0 percent and 5.0 percent for the foreign and local cost components, respectively;
(e) Financial costs and indicative investment schedule: The total financial cost is envisaged at US$ 47.5 million, with the foreign and local cost portions respective of US$ 18.3 million and US$ 29.2 million. Of this, 30 percent, 40 percent, and 30 percent will consecutively be disbursed;
(f) Operation and maintenance (O/M) costs: annual O/M cost is assumed to be 3.0 percent of the capital investment;
(g) Salvage value: No salvage value of the fixed assets due to the project in concern is assumed in the estimation of EIRR;
(h) Of the total 118,885 DALY estimated for Constanța 2005, share of CEH is 58.7 percent;
(i) Of the CEH in- and out-patients, emergency medical service (EMS) beneficiaries accounts for 33.5 percent;
(j) Of the EMS beneficiaries at CEH, 24.9 percent is the age cohort (age 15-59) for production activities in the society.

4. Results

4.1 Aggregate financial and economic costs, and economic benefits

The total financial cost of capital investment and
following O/M have been worked out to US$ 47.5 million and US$ 0.9 million per annum, respectively. The aggregate economic cost, likewise, turned out to respective of US$ 31.5 million and US$ 0.8 million as par mid-2006 price, while excluding transfer payment, taxes and duties, and price contingency from the financial cost. The economic benefits incurred to the proposed EMS in the county turned out to be US$ 213.8 million in aggregate, with the constant economic return of US$ 14.3 million per annum. Subsequently, net benefit of the component stands at US$ 168.2 million in total, with the annual benefit of US$ 13.3 million after the fourth year (2010).

4.2 Economic benefits
4.2.1 Incremental benefit: willingness to pay
4.2.1.1 Distribution of CVM-DBDC responses
YES-NO distribution for each of the five (5) bidding versions was figured out in such a way that almost one-fifth of the 449 interviewees responded in favor of “a monthly health contribution” regardless of the first and second bidding prices (YES-YES, 22.0 percent). Following this, YES-NO, NO-NO, and NO-YES came in the descending order while each of these accounting for 30.5 percent, 32.1 percent, and 13.6 percent, in that order. This distribution of responses by first bidding with a large proportion of YES-YES (very affirmative to payments) and a very small portion of NO-YES (a bit moderate to payments) would have reflected somewhat people's disguised “show-off”, in a sense trying to “please interviewers”, while answering in favor of monetary devotion to healthy life. Summary of distribution of responses by bidding version is in Table 2.

4.2.1.2 WTP estimated
Willingness to Pay (WTP) as a stated preference for the “use- and non use-” values coherently associated with healthy-life turned out to be US$ 17.9 per month per household (median value of 50 percent acceptance schedule), while accounting for 6.3 percent and 8.9 percent of gross and disposable incomes in Constanta, respectively. In the context of Romania as a whole (US$ 349.3 and US$ 248.5 in respective of gross and disposable monthly earnings), this estimate is intuitively perceived a bit high, due partly because that monthly income in the private sector is allegedly 30 to 40 percent higher than the figure in the official statistical documents.

With the monthly WTP estimate of US$17.9 per household and the beneficiary population of 419,525 in the region, the economic benefit incurred to the incremental EMS is estimated at US$1.6 million per annum, while the standard conversion factor (SCF) of 0.9 being applied to the financial benefit of US$1.8 million per annum. Note the average number of household members is 2.8 persons in Romania (2005).

<table>
<thead>
<tr>
<th>Version (%)</th>
<th>First Amount (US$)</th>
<th>Second Amount (YES)</th>
<th>Second Amount (NO)</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (3.0%)</td>
<td>6.4</td>
<td>10.7</td>
<td>3.2</td>
<td>42</td>
<td>37</td>
<td>5</td>
<td>12</td>
<td>1</td>
<td>97</td>
</tr>
<tr>
<td>2 (5.0%)</td>
<td>10.7</td>
<td>17.1</td>
<td>6.4</td>
<td>21</td>
<td>36</td>
<td>12</td>
<td>23</td>
<td>0</td>
<td>92</td>
</tr>
<tr>
<td>3 (8.0%)</td>
<td>17.1</td>
<td>21.4</td>
<td>10.7</td>
<td>13</td>
<td>30</td>
<td>12</td>
<td>33</td>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td>4 (10.0%)</td>
<td>21.4</td>
<td>32.1</td>
<td>17.1</td>
<td>14</td>
<td>21</td>
<td>14</td>
<td>36</td>
<td>1</td>
<td>86</td>
</tr>
<tr>
<td>5 (15.0%)</td>
<td>32.1</td>
<td>48.2</td>
<td>21.4</td>
<td>9</td>
<td>13</td>
<td>18</td>
<td>40</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>99</td>
<td>137</td>
<td>61</td>
<td>144</td>
<td>8</td>
<td>449</td>
</tr>
<tr>
<td>Share (%)</td>
<td></td>
<td></td>
<td></td>
<td>22.0</td>
<td>30.5</td>
<td>13.6</td>
<td>32.1</td>
<td>1.8</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: The authors
4.2.2 Social cost saved: DALY by Human-Capital approach

4.2.2.1 Key findings

(1) Disability adjusted life years (DALY) lost in Constanta is estimated at 118,825 person-years in 2005, of which premature mortality (YLL) is 71,188 while accounting for 59.9 percent.

(2) Disaggregating by gender, males lost 73,151 DALYs (61.6%), exceeding by 60.1 percent of females DALYs of 45,675.

(3) The leading specific cause of total disease burden was Ischaemic heart disease and stroke (8.4%), followed by, among others, hypertensive diseases (8.3%), Cerebrovascular diseases (6.9%), Mental and behavioral disorders due to alcohol (5.7%), Alzheimer disease (5.5%), Acute respiratory infectious diseases (4.5%), Chrrhosis of liver and chronic hepatitis (3.9%), Malignant neoplasm of bronchus and lung (3.8%), Injuries to head, neck, arm and leg (3.0%), Atherosclerosis (2.1%), and others. With this, the ten leading causes of disease burden account for 52.1 percent.

The leading 10 causes of DALY in Constanta in 2005 is given below.

4.2.2.2 Social cost saved measured by DALY

The economic benefit of the recovery of benefit-forgone (loss of earnings), as borne out by DALY, is estimated at US$ 12.7 million per annum by the formula as under:

\[
\text{Economic benefit} = \text{DALYs} \times \text{average monthly income in Constanta} \times \text{share of CEH beneficiary} \times \text{share of EMS beneficiaries} \times \text{share of productive age group} \times \text{standard conversion factor}
\]

4.2.3 LRMC pricing

With the discount rate of 8.0 percent over the 18 years of expected project life (with three years project implementation and operation of 15 years that follow), CRF being assumed to annualize the capital investment costs was estimated at 0.11, thus leading the annualized marginal cost of US$ 3.5 million in economic terms. With this, associated with the annual recurrent (OM) cost of US$ 0.9 million, the economic value of the project as reflected by LRMC pricing method in gross term is estimated at US$ 4.4 million equivalent per annum and US$ 65.9 million in total.

<table>
<thead>
<tr>
<th>No.</th>
<th>Cause</th>
<th>DALY (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ischaemic heart diseases</td>
<td>9,983</td>
</tr>
<tr>
<td></td>
<td>of which: Acute myocardial infarction</td>
<td>5,300</td>
</tr>
<tr>
<td>2</td>
<td>Hypertensive diseases</td>
<td>9,969</td>
</tr>
<tr>
<td></td>
<td>of which: Essential hypertension</td>
<td>9,856</td>
</tr>
<tr>
<td>3</td>
<td>Cerebrovascular diseases</td>
<td>8,218</td>
</tr>
<tr>
<td>4</td>
<td>Mental and behavioural disorders due to alcohol</td>
<td>6,798</td>
</tr>
<tr>
<td>5</td>
<td>Alzheimer disease</td>
<td>6,575</td>
</tr>
<tr>
<td>6</td>
<td>Acute respiratory infections</td>
<td>5,364</td>
</tr>
<tr>
<td>7</td>
<td>Cirrhosis of liver and chronic hepatitis</td>
<td>4,940</td>
</tr>
<tr>
<td>8</td>
<td>Malignant neoplasm of bronchus and lung</td>
<td>4,628</td>
</tr>
<tr>
<td>9</td>
<td>Injuries to the head, neck, arm, leg</td>
<td>3,518</td>
</tr>
<tr>
<td>10</td>
<td>Atherosclerosis</td>
<td>2,464</td>
</tr>
</tbody>
</table>

DALY by all conditions                           118,885

Source: The National Statistic Office, 2006
4.3 EIRR and sensitivity analysis

4.3.1 EIRR analysis WTP/DALY and LRMC method

The economic feasibility as borne out by the economic rate of return (EIRR) for the case of WTP/DALY is estimated at 32.2 percent, whereas the economic net present value (ENPV) being turned out to be US$ 102.4 million worth at the discount rate of 8 percent. Summarized is a net cash-flow of the Project, given below as Table 4 and Fig. 3.

Likewise, EIRR incurred to the alternative LRMC pricing method is elicited at 8.5 percent by LRMC pricing, with ENPV of US$ 1.1 million worth at the social discount rate (SDR) of 8 percent.

4.3.2 Sensitivity analysis

Sensitivity analysis indicating the resiliency against project risks is undertaken with variation in relevant parameters of (i) lower benefit by 10 percent, (ii) capital cost overrun by 10 percent, and (iii) one year delay in project completion. The results are as follows.

4.3.3 Conclusive remarks and policy evaluation

The measurement indices of EIRR and ENPV attributable to the proposed public intervention to EMS reveals economic viability high enough at 32.2 percent and US$ 102.4 million worth (social discount rate at 8 percent), while well exceeding the generally acceptable cut-off rate of EIRR at 6-8 percent for the health sector projects. With this, the proposed project profoundly reveals supremacy being deserved for the implementation in terms of the efficient allocation of scare resources in the Romanian economy.

Table 4 Summary Net cash-flow Table (WTP/DALY)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost</th>
<th>Benefit</th>
<th>Net Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>94</td>
<td>94</td>
<td>-94</td>
</tr>
<tr>
<td>2008</td>
<td>12.6</td>
<td>12.6</td>
<td>-126</td>
</tr>
<tr>
<td>2009</td>
<td>94</td>
<td>94</td>
<td>-94</td>
</tr>
<tr>
<td>2010</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
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<tr>
<td>2012</td>
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<td>1.6 12.7 14.3 13.3</td>
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<td>2013</td>
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<td>1.6 12.7 14.3 13.3</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
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<tr>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
<td>2016</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
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<td>1.6 12.7 14.3 13.3</td>
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<tr>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
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<tr>
<td>2019</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
<td>2020</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
<td>2021</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
<td>2022</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
<td>2023</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
<td>2024</td>
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<td>0.9</td>
<td>1.6 12.7 14.3 13.3</td>
</tr>
<tr>
<td>Total</td>
<td>31.5</td>
<td>14.2</td>
<td>45.6 23.9 190.0 213.9 168.3</td>
</tr>
</tbody>
</table>

Source: The authors

Table 5 Results of Sensitivity Analysis

<table>
<thead>
<tr>
<th>Method</th>
<th>Base Case</th>
<th>Benefit -10%</th>
<th>Cost +10%</th>
<th>l-year delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP/DALY</td>
<td>32.2 %</td>
<td>29.6 %</td>
<td>30.0 %</td>
<td>29.1 %</td>
</tr>
<tr>
<td>LRMC</td>
<td>8.5 %</td>
<td>5.1 %</td>
<td>6.4 %</td>
<td>5.1 %</td>
</tr>
</tbody>
</table>

Source: The authors
5. Discussions (Remaining Issues)

5.1 Disability weights

Disability weights are formalized and explicitly revealed social preferences in each of the societies or cultures for different states of health, thus making likely to be different set of weights in different country. The set of disability weights applied in the current research was that for the Eastern European countries was used by the World Bank and the National Institute for Health Research and Development in their joint 1998 study, and with this in view, the evolution of disability weighting by non-fatal impairment and illness would take place to comply with general perception and culture of the Romanian people.

5.2 Age weight modulation factor – K

The World Bank model originally gives age weights (denoted as K) that vary subject to the age of onset and/or demise, while giving more than one to ages between 9-54 and below one for those in the age group of 1-8 and 55 upwards, with the maximum weight at age 25. In the current research, and almost others of close relevance that likewise estimated DALY presumably set K at one (1.0) due to an extensive efforts and ambiguity as well to assign K to each of incidence cases in the context of Romanian local city in the specific period of 2005-2006. This theoretically led the DALY estimates closer to QALYs which does not incorporate age weight modulation factor in its formula. By consequence, there would be an urgent need for standardized methodology and the specific weights to be assigned in the in the temporary Romania.

5.3 Methodological limits

DALY estimation does require extensive epidemiological data. Due partly to this constraint, the research currently in place applied a “ratio method” with the disability factors commonly used for the Eastern European countries. With this, DALY lost for mental diseases would have been either neglected or underestimated by this methodology because these classified diseases are categorized as “non death-driven” diseases. With this and others, it would be a pressing need, in consideration of this theoretic setback and other methodological limits that the researcher had to compromise in carrying out the task, to undertake more multidisciplinary and comprehensive study on global burden of disease and injury to estimate inverse economic impact on the economy in line with the methodology as proposed by WHO/WB and other of relevance. In consequence, this will provide health policy decision makers a mechanism through which a better matching between the country’s disease burden and appropriate intervention measures on an allocative efficiency basis.

Acknowledgement

The research task was jointly undertaken by the University of Tokyo and the General Directorate of Health in Constanța County, the Ministry of Health (MOH) of Romania over the period of July 2005 through September 2006. Grateful acknowledgment is made, in particular, of academic supports and cooperation provided by Dr. Moazzam Ali, the University of Tokyo, and many other researchers in Romania in the form of hearty guidance, comments and advice on the overall structure and direction of the task. The researcher's outcomes as reflected in this paper have extensively been benefited from comments provided by and discussions held with these people, while all of the editorial errors and others remain with the principal author.

Notes

1 In 2005, the total in-and out-patients in Romania was 4,479,847. (Source: The Public Institute of Health Research and Development, Regularizar 2005)

2 IRR, by definition, is a discount rate that equalizes discounted net benefits (benefit-cost) over the project life, and mathematically expression as follows. IRR = r :
that makes \( \Sigma (B-C_t \times (1+r)^{-t}) = 0 \) where \((B-C_t)\) represents net benefit in the year \( t (t = 1, \ldots, n) \)

3 \( \text{NPV} \equiv \Sigma \{ (B-C_t)/(1+r)^{-t} \} \) where \( t = 1, 2, \ldots, n \), and \( r \) as social discount rate.


6 Number of the sample of around 450 at maximum was calculated while using the statistical software of EPIINFO version 6 with the parameters of (i) population size of 750,000, (ii) Non-previous study alike, (iii) statistical confidential level of five (5) percent, and (iv) analytical precision level of 95 percent.

7 Hearty gratitude is due to Professor K. Kuriyama at Waseda University, Japan, for his free software of CVM by EXCEL, version 2 downloaded from the site: www.kkuri-mm.waseda.ac.jp


10 In so doing, the ICD-9 coding was duly converted to ICD-10 coding. In this connection, it is gratefully acknowledged to have received thoughtful academic advises and data processing from Dr. Marcu and Ms. Galan of the Public Health Institute in Bucharest.

References


Sassi F., Calculating (2006). Calculating QALYs, comparing QALY and DALY calculations. Health Policy
Planning, 21(5), Oxford University Press, 402-408.


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