ECONOMIC ANALYSIS

A. Introduction

1. The economic analysis was undertaken in accordance with the *Guidelines for the Economic Analysis of Projects* and *Handbook for the Economic Analysis of Health Sector Projects* of the Asian Development Bank (ADB).[1] The analysis reviews the project's economic contribution to the health system and its effects on the beneficiaries and the health care workers. The government's longer-term fiscal position was also estimated to assess the feasibility of additional cofinancing from the public health budget. The Fifth Health Sector Development Project has no revenue-earning components and will focus on improving and sustaining the quality of hospital services, and improve patients' and health workers' safety in hospitals in Mongolia. The objectives of the proposed Fifth Health Sector Development Project are to (i) improve the safety of blood transfusions, (ii) strengthen medical waste management, and (iii) prevent and control hospital-acquired infections.

B. Economic Parameters and Assumption

2. The economic analysis was conducted over 20 years and 25 years inclusive of civil works equipment supply and other investment support. Project implementation is expected to commence in July 2013 and continue to June 2018. Economic benefits and costs were expressed in US dollars at constant 2012 prices. A shadow wage rate factor of 1.2 was applied to the wages of skilled labor and a factor of 0.7 was applied to the wages of unskilled labor, at the domestic price level. Other financial costs were adjusted to economic prices using a shadow exchange rate factor of 1.019.[2]

C. Economic Benefit Assumptions

3. The project supports the Mongolian health system's efforts to improve and sustain the quality of hospital services, and improve patients' and health workers' safety in hospitals. Economic internal rates of return (EIRRs) were derived for the project by analyzing the most important quantifiable economic gains and providing conservative estimates.

4. **Improve the safety of blood transfusions.** This project component will benefit the total population of Mongolia. It will improve blood safety in the health care delivery system, providing equipment training to concerned personnel and organizing a blood donor management system, including public awareness raising. It will also support the reduction of hospital-acquired infections, as described under the component for prevention and control of hospital-acquired infections, in ways that are expressed in qualitative and quantitative terms (paras. 7–12).

5. **Strengthen medical waste management component.** This project component will promote public health and improve the lives of people in the project area, which has a total population of about 1,850,000 with 13,500 health care workers.[3] The adequate recycling of

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[1] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila; and ADB. 2000. *Handbook for the Economic Analysis of Health Sector Projects.* Manila.

[2] Rates calculated for ADB. 2004. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Technical Assistance Grant to Mongolia for the Regional Road Development Project.* Manila (Loan 2087-MON, for $37.13 million, approved on 22 July 2004); and ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Grant to Mongolia for the Regional Road Development Project–Supplementary*. Manila (Grant 0199-MON, for $16 million, approved on 30 March 2010).

[3] The number of beneficiaries (1,850,000) reflects the population of Ulaanbaatar and the population of nine *aimags* (provinces). In Ulaanbaatar, eight district hospitals, three tertiary hospitals, and the National Center for

biohazardous waste will mean less air, water, and soil pollution associated with the extraction, refining, and processing of chemicals and liquids. This component will also support the reduction of hospital-acquired infections. In addition, this component will return directly economic quantifiable benefit through the reduction of energy cost by using autoclaves instead of incinerator equipment.

6. **Prevent and control of hospital-acquired infections component.** This component will improve the lives of people in the project area by reducing hospital acquired infections. Calculations are based on the current rates of hospital-acquired infections and the reduction potential through implementation of the component. This component will return economic benefits through (i) savings generated via the reduction in treatment cost, and (ii) productivity gains through the reduction in hospital-acquired infections of the economic active population.

D. Explanation of Economic Benefits

7. Table 1 presents an overview of the economic benefits that were analyzed. A detailed description is also provided in this section.

Table 1: Overview of Monetarily Quantified and Non-Quantified Benefits

Component	Monetarily Quantified
Safe Blood Transfusion	
Positive impact on the years of healthy life of patients and health workers by reducing the unintentional transmission of HIV, syphilis, and hepatitis B and C	No
Increase in the number of blood donors should have a positive impact by reducing the mortality rate by injuries due to the prompt availability of blood	No
Increase in the number of blood donors will improve the availability of safe blood, ensuring safe deliveries, and increase the number of life-years gained by reducing the maternal mortality ratio	Yes
Blood donor management system will allow life-savings reaction in the case of emergency and will improve the marketing of blood donations	No
Capacity for future development in health care	No
Medical Waste Management	
Reduced energy cost	Yes
Reduction in blood-borne infections among health care workers and an increase in the number of years of healthy life	No
Increase in years of healthy life of the population by proper treatment of solid and liquid waste	No
Reduction in CO_2 from the health care sector via the introduction of plastic recycling	No
Hospital Hygiene and Infection Prevention and Control	
Reduction in treatment cost of hospital-acquired infections	Yes
Productivity gain	Yes
Secondary benefits of training on hygiene matters	No

CO_2 = carbon dioxide.
Source: Asian Development Bank.

1. Safe Blood Transfusion Component

8. This component will improve blood safety throughout the health care delivery system, providing equipment training to concerned personnel and organizing a blood donor management system, including public awareness raising. The screening of blood will have a positive impact on the years of healthy life of patients and health workers by reducing the unintentional transmission of HIV, syphilis, and hepatitis B and C. This benefit has not been monetarily quantified. The project aims to increase the number of donors (currently about

Communicable Diseases are implementing components 2 and 3. Eight *aimag* hospitals and a tertiary hospital are located in an *aimag*, which will also be implementing components 2 and 3. The number of health care workers benefitting from the project reflects the total number of health care workers working in the selected facilities.

22,000 or 0.8% of the current population) through blood donors' campaigns. The number of donors is expected to increase to 1.2% of the population (about 30,000) in the medium term. This increase will improve the (i) treatment injuries; (ii) handling of complications during pregnancy and childbirth; and (iii) management of severe childhood anemia, trauma, and congenital blood disorders. The increase in the number of donors should have a positive impact by reducing the mortality rate caused by injuries (78 per 100,000 population in 2010). This benefit has not been quantified monetarily. The increase in the number of donors should have a positive impact by reducing the maternal mortality ratio, which was 63 per 100,000 live births in 2010 (according to World Health Organization statistics. The maternal mortality ratio is projected to fall by an average of 15% because of the increase in the number of blood donors.[4] The monetary value of the number of life-years gained was calculated by considering a value of $4,200 per year (60% of the gross domestic product [GDP] in 2011 applied to the active (working) population) and the total economic benefit was calculated to be about $0.7 million per annum. Currently, no voluntary blood donor database exists to facilitate emergency donations. The project envisages the implementation of a donor management system that will allow life-saving reactions in case of emergencies and will improve the marketing of blood donations. This will have a positive impact on the number of years of life gained but this value has not been quantified monetarily. Demand for blood will increase as a result of lifestyle- and age-related chronic diseases, including cancers and cardiac diseases that require blood for treatment.

2. Medical Waste Management Component

9. Biohazardous waste is disposed of via incinerators. Adoption of the autoclave system will produce energy savings—it costs MNT875 to dispose of 1 kilogram (kg) of biohazardous waste via incinerator but only MNT44 to dispose of the same amount via autoclave. The savings generated per kg of biohazardous waste are MNT831. The biohazardous waste produced per inpatient-day is about 0.17 per kg, so the total savings per inpatient-day amount to $0.11. The total savings generated amounts to about $250,000 for 2012.

10. The total number of health care workers who will benefit directly from this component is 13,500. Health care workers are at risk of occupation-related accidents during the transportation of waste, with the threats of infection of blood-borne diseases (hepatitis B, hepatitis C, and HIV). A study conducted in 2010 showed that 42.4% of 354 primary, secondary, and tertiary health care workers in Ulaanbaatar had at least one infection. Hepatitis B virus was the most common infection. The same study showed that about 87% of health care workers had been injured by sharps.[5] This component will introduce reusable sharps containers for the safe collection and transport of sharps. It will contribute to the reduction of blood-borne infections among health care workers and increase the number of years of healthy life, but this value has not been quantified monetarily. Solid and fluid waste, if left in unsanitary conditions without proper disposal, can cause diseases and lead to infections—reducing the years of healthy life of the population. Currently, formaldehyde is not disposed of adequately, with the potential risk of harming groundwater and becoming carcinogenic. Hospitals also generate solvents which, if not disposed of adequately, create occupational health and safety risks. No monetary value is attached to this benefit. The project will also contribute to the reduction of carbon dioxide from the health care sector by introducing plastic recycling. Plastics will be collected separately, undergo a second sorting process, and be shredded and sold as raw material.

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[4] K.S. Khan et al. 2006. WHO analysis of causes of maternal death: a systematic review. *Lancet.* 28 March. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(06)68397-9/abstract

[5] Various publications since 1998 report a wide range of figures for hepatitis B and C carriers in various population groups in Mongolia (blood donors, health care workers, general population, males, and outpatients). The reported proportions vary from 8% to 29% for hepatitis B and 2% to 48% for hepatitis C carriers.

3. Hospital Hygiene and Infection Prevention and Control Component

11. Hospital-acquired infections create considerable cost for the health care system. Based on the available evidence, hospital-acquired infections can include a prolonged hospital stay, long-term disability, increased resistance of microorganisms to antimicrobials, and consequently, a significant additional financial burden for health care systems, high costs for patients and their families, and unnecessary deaths. Health care workers need to understand the risk of hospital-acquired infections and how to evaluate the cost savings of any infection prevention intervention. Hospital hygiene and infection prevention and control will be strengthened through an effective hospital-acquired infection surveillance system and increased capacity of health authorities, health care workers, and administrative staff on infection prevention and control. The project will have a direct benefit on the number of patients affected by hospital-acquired infections, which is estimated to be about 22,000 (8% of total inpatient admissions are assumed to have hospital-acquired infections, which represents 15% of the project population). A prevalence study showed a substantially higher hospital-acquired infection rate at tertiary hospitals, compared with official data (5.40% versus 0.05%).[6] The figure is still much lower than the rates found in other developing countries (prevalence ranged from 5% to 19%, with most studies reporting a value higher than 10%).[7] In addition, as reported in the local press, in March 2010, Mongolia experienced 28 hospital-acquired infections among newborns, of whom five died, as a result of poor infection control clinical practices. Therefore, 5.4% is a conservative estimate, considering the high usage of antibiotics in Mongolian hospitals.[8] Proper reporting and evaluation of hospital-acquired infections will start in 2013; the conservative value of 8.0% has been taken as an indicative baseline for the economic analysis. The implementation of infection prevention and control in developing countries can usually lead to a reduction in the rate of hospital-acquired infections of 30%–40%.[9] For the calculation of economic benefits, a reduction of 30% has been considered. According to various studies, the length of stay in hospitals caused by hospital-acquired infections is 7–30 days. Calculation of the economic benefit considers a reduction of 8 days. The cost of treatment of hospital-acquired infections per inpatient-day is considered to be $100, which is conservative in comparison with costs indicated in other studies.[10] The total reduction of treatment cost for 2012 would amount to $5.4 million.

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[6] Ministry of Health. 2011. *One Day Prevalence Study*. Ulaanbaatar.

[7] Mongolia declared 85 cases of hospital-acquired infections in 2012 (Ministry of Health. 2011. *Health Indicators*. Ulaanbaatar) against World Health Organization (WHO) estimates of 3.5%–10% of treated cases in hospitals in the Asia-Pacific region; WHO estimates represent 21,000–70,000 expected cases of hospital-acquired infections in Mongolia.

[8] The excessive use of antibiotics prevents the transmission of hospital infections.

[9] R. W. Haley et al. 1985. Study of the Efficacy of Nosocomial Infection Control (SENIC) Project *American Journal of Epidemiology*. 121 (2). pp.159-67 and pp. 182-205. In 1985, the Study of the Efficacy of Nosocomial Infection Control (SENIC) Project was published, validating the cost–benefit savings of infection control programs. Such programs were proven to be effective as hospitals with certain practices reduced their infection rates by 32%, compared with an increase of 18% in hospitals without these components over a 5-year period.

[10] Values confirming the assumptions may be found in the following studies: N. Kasatpibal et al. 2005. Extra Charge and Extra Length of Postoperative Stay Attributable to Surgical Site Infection in Six Selected Operations. *Journal of the Medical Association of Thailand*. 88. pp. 1,083–1,091; M. Taye. 2005. Wound Infection in Tikur Anbessa Hospital, Surgical Department. *Ethiopian Medical Journal*. 43. pp. 167–174; A. Kothari et al. 2009. Costs Associated with Hospital-Acquired Bacteraemia in an Indian Hospital: A Case-Control Study. *Journal of Hospital Infection*. 71. pp. 143–148; and V. D. Rosenthal et al. 2003. The Attributable Cost, Length of Hospital Stay, and Mortality of Central Line-Associated Bloodstream Infection in Intensive Care Departments in Argentina: A Prospective, Matched Analysis. *American Journal of Infection Control*. 31. pp. 475–480.

12. This component will contribute to productivity gains as the economically active population will be able to return to work faster. The economically active population in the selected area is 37%. The reduction in the total number of days spent in hospital was multiplied by 37% and then multiplied by the daily GDP per active population. The current GDP per capita is $2,562 per annum, which corresponds to GDP per active capita of almost $7,000 per annum or $19.22 per day. The productivity gain for 2012 would correspond to almost $590,000. Considering that training in hospital hygiene and infection prevention and control will be provided to a substantial number of female health care workers, who are also responsible for the education and care of children, it can be expected that this measure will have secondary beneficiaries for impact on hygiene practices outside the hospital environment.

E. Economic Cost Assumption

13. Economic costs are based on the estimates of annual project costs. Base costs plus physical contingencies were converted to economic costs on the basis of skilled and unskilled labor costs and other costs, including operation and maintenance. Additional recurrent costs have been included to cover maintenance of equipment, reagents, and other consumables costs arising from increased testing. All estimated taxes have been deducted and financial costs have been converted to economic prices through the application of shadow wage factors of 1.2 for skilled workers and 0.7 for unskilled workers, and a shadow exchange rate factor of 1.019 (footnote 2).

F. Economic Internal Rate of Return

14. The economic opportunity cost of capital for ADB projects is 12%. Using conservative estimates of project implementation, the EIRR for the project is 17.51% so the project can be considered economically viable. By reducing the total value of the economic benefit by 20%, the EIRR is 13.76%. By increasing the operating cost by 30%, the EIRR is 17.21%. The combination of both changes would result in a EIRR of 13.4%. The EIRR by component is summarized in Table 2. The highest contribution to the positive EIRR is provided by the component on prevention and control of hospital-acquired infections and the lowest contribution comes from the component on improvement of safe blood transfusion.

Table 2: Economic Internal Rate of Return by Component (%)

	Scenario 0	
Item	**EIRR 20 years**	**EIRR 25 years**
Safe blood transfusion	13.44	14.69
Medical waste management	18.75	19.60
Hospital hygiene and IPC	23.25	23.95
Total Project	**17.51**	**18.51**

EIRR = economic internal rate of return, IPC = infection prevention and control.
Source: Asian Development Bank.

15. The sensitivity analyses by component, as well as the switching value of the decrease of benefit and increase of operating cost for each component, are provided in the Economic Analysis (Complementary Information).[11]

[11] Accessible from the list of linked documents in Appendix 2.