HEALTH ECONOMICS: COST-BENEFIT ANALYSIS OF AN INVESTMENT PROJECT TO FINANCE THE PROCUREMENT OF A MAGNETIC RESONANCE IMAGING DEVICE

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Introduction: Chronic lack of funds in Bosnia-Herzegovina's (BH) healthcare system is a fact. A permanent way to overcome the current state is through fundamental healthcare system reform at the national level which would be a long-lasting process. The only could currently be done are just temporary solutions. One of them is finding temporary, alternative solutions to the inflow into health funds. **Aim**: To point the necessity of intensifying the impact of economic profession in the healthcare system such as practice in developed healthcare systems. Respecting the unification of Evidence Based Medicine (EBM) and economic evaluation principles, would be easier to overcome important doubts about decision making and maximize the ability to choose more favorable business options. Once the ultimate goal of economic evaluation be accepted- achieving the maximum amount of health per unit of money invested, it would be avoided the misconception that it represents a simple cut in healthcare costs. **Material and methods**: Market data were used to provide the cost of new Magnetic Resonance Imaging device (MRI), including University Clinical Center's (UCC) Tuzla prices of Computer Tomography (CT) and MRI procedures and the amount of expenses for this purpose approved by Health Insurance Institute (HII) of Tuzla's Canton (TC) for 2017 year. For the purpose of economic evaluation were used Cost-Benefit Analysis (CBA) and two methods of investment projects evaluation- Net Present Value (NPV) and Discounted Payback Period (DPP). **Results**: After considering optional ways to raise funds for an investment project of providing a new MRI device, two options proved most favorable. The first one- project in 50% co-financed by European Bank of Reconstruction and Development (EBRD) grant and the rest by some domestic banks at an interest rate of 5%. Next in acceptability was by EBRD financing option with 4 years grace period. Depending on the viewing angle of current needs of the institution, it should be considered which of these options to give priority. **Conclusion**: After accounting treatment of options we were given an order of funding by eligibility, the complete analysis should be considered in terms of economic evaluation role- as an advisory or as finding options, should not be ever understood as final or binding. The most important thing is to understand the economic evaluation message in healthcare- the ultimate decision which of the offered financial option to choose should be left to healthcare profession.

Key words: economic evaluation, procurement of MRI device, CBA.

INTRODUCTION

Consumption growth in healthcare can not be stopped, but healthcare financing as well as cost control and efficiency gains must be raised to a higher level [1]. Increasing allocations on the healthcare system are a fact and the reasons of this are numerous:

-extending access to basic health services to almost the entire population;

-continuous development of medical technology;

-economic development and growing demand for health services;

-an extension of life time expectancy and an increasing participation of group over 65-year-old population in the total population;

-emigration of the working age population.

Developed European countries for health sector financing allocate 5-7% of Gross Domestic Product (GDP) [1]. GDP growth also provides funding for the growth of health needs in the future period. The situation in Bosnia-Herzegovina (BH) is such that on an annual level we even allocate 9% of GDP for health sector financing [2,3], which is a huge percentage and is a consequence of low GDP. However, analyzing at the results of such releases, it is clear that this amount is insufficient in relation to needs. How to overcome this situation? Without fundamental healthcare system reform at the national level, there is not a permanent solution of healthcare financing. The only could currently be done are just temporary solutions. One of them is finding temporary, alternative solutions to the inflow the resources into health funds which would be a step up from the usual way.

The other solution to inflow the resources is reallocation of existing funds obtained by controlling the use of current funds. It is a fact that healthcare funds are limited. The way resources are spent should be improved by improving the efficiency of spending them. In the developed world the impact of the economic profession in the healthcare system is being studied as a separate field called the "Health Economics" for quite some time now [3]. The essence is in unification of Evidence Based Medicine (EBM) and economic evaluation principles. In healthcare process of decision making the roll of economic profession is advisory. It is about identifying options during make of important decisions, then comparing the costs and benefits of each. Examples are: financing decisions, procurement procedures, resources spending analysis, business analysis, effectiveness analysis. The role of healthcare professionals is the ultimate choice of the offered options. That means economic professional role would be advisory and final decision would be entrusted to healthcare profession. Ultimate goal of economic evaluation in health system is achieving the maximum amount of health per unit of money invested. To avoid the misconception it is the most important to understand the goal of economic evaluation correctly- to avoid or minimize inefficient disposal of healthcare resources not as simple cut in health costs.

Michael Grossman's model [4] of health production has been extremely influential in this field of study and has several unique elements that make it notable. Grossman's model views each individual as both a producer and a consumer of health. Health is treated as a stock which degrades over time in the absence of "investments" in health, so the health is viewed as a sort of capital.

In this paper we considered one of the more intense impact of economic evaluation in procurement in the field of radiology- proposal of financing options in procurement and their comparative analysis.

Hypothesis

Alternative Hypothesis:

-It is possible to obtain financing options for the purchase of a new Magnet Resonance Imaging device that would be cost effective for a period of less than three years.

Null Hypothesis:

-It is not possible to obtain financing options for the purchase of a new Magnet Resonance Imaging device that would be cost effective for a period of less than three years.

MATERIAL AND METHODS

Research methodology

Materials:

Study used data on the average market price of a new MRI device which could satisfy the requirements of an institution as University Clinical Center (UCC) Tuzla is today. The fact is that UCC already dispose of two MRI devices. Only one is functional and at the same time quite depreciated, so there is definitely a huge requirement to purchase a new one. The market price of procuring an adequate MRI device is between 2.000.000-3.000.000 KM. In the study we used a price of 2.000.000 KM. We also considered three proposals on project financing that could realistically be achieved in the market. The price of individual MRI procedures depending by the body region. Price of 300 KM was taken as an average price. A fact that support the justification of the study is that an adequate, fully equipped space in accordance with the legal regulation for the placement and getting started of MRI device into operation already exists. That is the place of an existing, non-functional MRI device that is not worth repairing due to the cost of service. Otherwise the provision of the space that the device accommodation requires considerable expenses from construction, protection and equipping a space usually involves a huge expense. So, the fact of already fulfilled above mentioned should be also considered.

Imaging method financial effects

The study began with the important question- how to provide the funds needed for the investment project of a new MRI device procuring?

In order to be able to send an application to any of the institutions possibly willing to finance the project, it is necessary to make an evaluation of the justification of its implementation. There are different methods available for these purposes. The most frequently used is Cost-Benefit Analysis (CBA). It is defined as the return on investment over a period of time or through realized profit. This method answers the question of whether the benefits of project implementation outweight the investment required for the project, additionally answers what time of period would be required for the project to return the investment, what interest rate provides the required payback period etc. [3].

In this case, as the public health institution were considered, profit is an important but not the primary goal. The aim of this investment project is also to contribute a social, intangible benefit, presented as a non-economic effect, which may be much more significant than economic effect itself. Nevertheless, UCC is considered as the leading health center in the most populous canton in BH, gravitating 500.000 patients who need to be provided satisfactory access to healthcare. Especially it would be considered that UCC dispose of a proven, highly educated staff, capable of providing satisfactory service for the indicated number of patients, but also needs to be provide adequate working conditions. Additionally, should not to be neglected, the fact that MRI diagnostics exclude exposure to ionizing radiation otherwise in large doses present during Computed Tomography (CT) diagnostics.

Methods

In the study we used: Cost-Benefit Analysis (CBA) and methods of evaluation and selection of investments-

Net Present Value (NPV) and Discounted Payback Period (DPP).

CBA is a fundamental part of the Feasibility study and an important element of the cohesion policy of the European Union (EU). Therefore, CBA represents a mandatory part of the application documentation of large projects financed by EU structural funds, i.e. pre-accession EU funds that BH has an access. It is necessary to choose the best solution and policies that would be competitive in applying for funds and at the same time facilitate EU commission in the decision to allocate funds in the way the most favorable to us. As we get closer joining the EU, increasing funds for big investments will be more available to us. Ours is to demonstrate competencies in the field of making quality CBA. In addition to quality CBA, a prerequisite for the application is to ensure transparent financial management of the applicant institution. It is essential that the applicant's business is presented and audited as rational and verifiable.

CBA implementation phases used in our study was as followed:

-Phase 1: Defining the project to be analyzed as well as the time period which the analysis related;

-Phase 2: Determining the benefits and costs of the collected bids;

-Phase 3: A choice between the offered options.

There are different methods in the evaluation and selection of investments.

NPV methods involves reducing to present value by discounting the expected cash or Cash Flows (CF) by the required rate of return, summing the CF obtained and comparing them with the initial investment amount. By NPV method project fulfills the basic eligibility criteria if NPV result is greater than zero.

DPP is method which represents the time that investment required to generate enough cash flows to cover the initial invest or how long period it required the investment begins to make a profit.

Search procedures

Cost-Benefit Analysis

Phase 1: Defining the project to be analyzed as well as the time period which the analysis related

We defined the project as a way of procuring funds of the amount of 2.000.0000 KM for the purchase of a new MRI device on University Clinical Center (UCC) Tuzla with a repayment period of 3 years. Therefore, it is necessary to request the offers of investors willing to participate in the project in order to make the most favorable choice based on the conditions they offered. Obtaining a loan should not be a bigger problem since the founder of UCC is a guarantee for loan repayment which means that the loan is allocated to the Tuzla Canton (TC) Government. Also because of the credit purpose it is possible to get very favorable conditions, more favorable than those considered in the study- a

longer repayment period and a more favorable interest rate, possibly a longer grace period.

Phase 2: Determining the benefits and costs of the collected bids

It was necessary to analyze at least three project realization options with clearly defined conditions for each, then compare the results and choose the most suitable. During Cash Flow formation we also considered the unnecessary cost of CT procedures from a recent performed study [5]. Considering the financing options in more detail, it should certainly include the costs of other CT procedures that proved as unnecessary if another MRI device would be able to carry out much more detailed analysis.

Cash Flow forming (the same used in all options): The price of CT lumbosacral spine (L/S) performing is 178,47 KM. Considering results of mentioned study [5] which include a year period, it is established that 49 (71%) of undertaken procedures was unnecessary, the cost of these procedures we would regard as unnecessary expense, potential savings in the calculation by purchasing a new MRI device as 49x178,47 KM=8.745,03 KM.

The price of MRI L/S performing is 310 KM. As the existing, functional MRI device performed not only L/S procedures, but numerous cheaper and more expensive ones, for the average price of MRI procedures used in this study we took the price of 300 KM. We also expect different types of procedures to be performed on the new device as well.

We assumed that the new MRI device would have Cash Flow as followed which we assumed as realistic regarding the current number of procedures:

1st year: 5 procedures x 2 shifts x 22 working days x 12 months x 300 KM=792.000 KM;
2nd year: 6x2x22x12x300=950.400 KM;
3rd year: 6x2x22x12x300=950.400 KM.

If we add to the CF above the amount of unnecessary cost of just one type of CT performing (CT L/S unnecessary costs), we would have CF as followed:
1st year: 792.000+8.745= 800.745 KM;
2nd year: 950.400+8.745=959.145 KM;
3rd year: 950.400+8.745=959.145 KM.

RESULTS AND DISCUTIONS

We assumed that we received these offers in response to potential financiers:

-Project in total amount financed by some of BH banks with interest rate of 5%;

-Project co-financed by EBRD (50% grants) and the rest financed by some of BH banks with interest rate of 5%;

-Project in total amount financed by EBRD (option with 2% interest rate without grace period and option with grace period of 3 years);

-Option of retaining the existing state ("Do nothing option").

Option A) Project in total amount financed by some of BH banks with interest rate of 5%:

Better conditions (lower interest rate, grace period) could be negotiated considering public health institution is involved, the amount and purpose of the requested funds as well as founder of UCC guarantees the repayment of the loan.

Table 1. Option A- The financial calculation

Year	NCF	Discounted NCF	Cumulative Disc. NCF
0	-	-	(2.000.000)
1	800.745	762.614	(1.237.386)
2	959.145	913.471	(323.915)
3	959.145	913.471	589.556
Total	2.719.035	2.589.557	-

NPV=(800.745/1,05+959.145/1,05+959.145/1,05)-2.000.000=(762.614,29+913.471,43+913.471,43)-2.000.000=2.589.557,15-2.000.000=589.557,15KM (Table 1).

Result: NPV>0. Meaning: The project is cost effective by the NPV method.

DPP=2+(323.915/913.471)=2+(0,3546x365 dana)= 2 years and 129 days.

Result: PP=2 years and 129 days. Meaning: The project payback period is 2 years and 129 days.

Conclusion: By default, the project is acceptable by NPV method and the period required for the investment to generate enough NCF to cover the initial costs is 2 years and 129 days.

Option B) Project co-financed by EBRD (50% grants) and the rest financed by some of BH banks with interest rate of 5%:

A largely realistic option. EBRD funds would become even more accessible to us as we would approaching to EU.

Table 2. Option B- The financial calculation

Year	NCF	Discounted NCF	Cumulative Disc. NCF
0	-	-	(1.000.000)
1	800.745	762.614	(237.386)
2	959.145	913.471	676.085
3	959.145	913.471	1.589.556
Total	2.719.035	-	-

NPV=(800.745/1,05+945.145/1,05+945.145/1,05)-2.000.000=762.614,29+913.471,43+913.471,43=2.589.557,15-1.000.000=1.589.557 KM (Table 2).

DPP=1+(237.386/913.471)=1+0,26(x365)=1 year and 95 days.

Conclusion: By default, the project is acceptable by NPV method and the period required for the investment to generate enough NCF to cover the initial costs is 1 year and 95 days.

Option C) Project in total amount financed by EBRD (option with 2% interest rate without grace period and option with grace period of 3 years):

It is not a grant option, although it would certainly be the most desirable option. We considered two options:

-Option C1: Without grace period with 2% interest rate;

-Option C2: With grace period of 3 years.

Table 3. Option C1- The financial calculation

Year	NCF	Discounted NCF	Cumulated Disc. NCF
0	-	-	(2.000.000)
1	800.745	785.004	(1.214.996)
2	959.145	940.338	(274.658)
3	959.145	940.338	665.680
Total	2.719.035	2.665.680	-

NPV=(800.745/1,02+959.145/1,02+959.145/1,02)-2.000.000=(750.004,12+940.338,24+940.338,24)-2.000.000=2.665.680,60-2.000.000=665.680KM (Table 3).

DPP=2+(274.658/940.338)=2+(0,29x365)=2 god i 106 dana.

Conclusion: By default, the project is acceptable by NPV method and the period required for the investment to generate enough NCF to cover the initial costs is 2 years and 106 days.

Table 4. Option C2- The financial calculation

Year	NCF	Cumulative NCF	Disposal funds during grace period
0	-	(2.000.000)	-
1	800.745	(1.199.255)	800.745
2	959.145	240.110	1.759.890
3	959.145	719.035	2.719.145
Total	2.719.035	-	-

NPV=(800.745+959.145+959.145)-2.000.000= 2.719.035-2.000.000=719.035KM (Table 4).

PP=2+(240.110/959.145)=2+0,25(x365)=2 years and 91 days.

Conclusion: By default, the project is acceptable by NPV method and the period required for the investment to generate enough NCF to cover the initial costs is 2 years and 91 days. This option is very convenient as we are free to dispose of the funds the entire 3 years. That means we have an open interest free option for investing in other own projects. The funds freely available to us during the first 3 years are constantly increasing from 800.745 KM at the end of the 1st year to 2.719.145 KM at the end of the 3rd year. After the expiration of 3 years the funds would start to returning to EBRD at the agreed rate.

Option D) Retaining the existing state ("Do nothing option"):

This option would not require the involvement of any resources- in terms of analyzing, tracking trends in healthcare, seeking investors etc. Whether it would be a long-term sustainable condition? This way UCC would lead itself to the following situation: it would continuously be obliged to respect the contract of radiological device servicing in the amount of 20.000 KM per year; there would not be new NCF; the waiting lists would still exist and there is a growing risk that the existing MRI device would fail completely. On the other side are institutions that constantly invest in equipment innovation and emerge as region's leaders in healthcare providing.

Calculation: (20.000 KM+8.745 KM)x3 years=60.000+ 26.235=86.235 KM.

Conclusion: If we analyzed under these conditions a period of 3 years, we would come to amount of 86.235 KM which we paid but got nothing but maintaining our existing balance. If we took an amount of 2.000.000 KM from commercial banks for the purpose of this study investment project of interest rate of 5%, the calculated interest for 3 years period would be approximate to that amount and we would have a realized project.

Phase 3: A choice between the offered options

These are the results that above-mentioned options would have (Table 5).

Table 5. Budget review of all financing options

Option	The total amount of banks with 5% interest	EBRD 50% irreversible+ bank 50% with 5% interest	EBRD without grace period with 2% interest	EBRD with grace period of 3 years
NPV	589.557 KM	1.589.557 KM	665.680 KM	719.035 KM
DPP	2 years and 129 days	1 year and 95 days	2 years and 106 days	2 years and 91 days

After all options have been analyzed, we arrange them in order of eligibility (Table 6).

Option	EBRD 50% irreversible+ bank 50% with 5% interest	EBRD with grace period of 3 years	EBRD without grace period with 2% interest	The total amount of banks with 5% interest
NPV	1.589.557 KM	719.035 KM	665.680 KM	589.557 KM
DPP	1 year and 95 days	2 years and 91 days	2 years and 106 days	2 years and 129 days

Table 6. Financing options by eligibility

Comment:

Of the options analyzed would certainly be the most advantageous option B- Project co-financed by EBRD (50% grants) and the rest financed by some of BH banks with interest rate of 5%. This option would have the highest NPV and the reason is that it would return of 50% of investment funds, 1.000.000 KM. Consequently, a payback period would be the shortest- for only 1 year and 95 days the initial investment would be paid off.

The next option on eligibility would be an option C2- Project in total amount financed by EBRD with grace period of 3 years. NPV would be 719.035 KM and investment would be paid off for 2 years and 91 days. An interesting fact of these option is that by beginning of the 4th year UCC would have an open interest-free funds for investing of other own projects. The amount of these funds would be equal to cumulative NCF and would increase from 800.745 KM at the end of 1st year to 2.719.145 KM at the end of 3rd year. Depending on the current financial needs of UCC, this option could be found side by side with the first option and quite realistically it could be considered as the most acceptable.

The other two options show minor differences.

"Do nothing" option is definitely the most unacceptable for the reasons outlined above.

On the other hand, analyzing the data from 2017 year on payment to healthcare institutions in TC that based of approved and performed procedures, we are getting to data that allow us to calculate savings as follows:

-A total amount of Health Insurance Institute (HII) of Tuzla's Canton (TC) at 2017 year for MRI procedures was paid 1.345.981 KM, of that for UCC Tuzla 65%, i.e. 1.345.981x0,65=882.800 KM;

-A total amount at 2017 year for CT procedures was paid is 2.332.357 KM, of that for UCC Tuzla 1.973.934 KM, i.e. 84% (2.332.357 KMx0,84).

Considering recently study results [6] that 71% of CT L/S undertaken procedures as unnecessary, based of if we considered the same percentage of other undertaken CT procedures as unnecessary, the calculation would be as followed: 1.973.934 KMx0,71(i.e.71%)=1.401.493,14 KM. This is the amount of unnecessary cost of CT procedures that could be avoided both by avoiding them and adjusting of existed algorithm of radiological procedures.

It is clear that the funds for our study project of 2.000.000 KM could be saved in less than 1,5 year of period, i.e. 2.000.000:1.401.493=1,427, (means 1 year and 0,427x365 days)=1 year and 156 days. So, this would be the most correct option for providing funds, without borrowing and paying interests and it could be realistically achievable if the available funds were used in a more rational way.

Installing new MRI device also opens option for algorithm adjustment of numerous diagnostic procedures. In practice it would mean the following- there are indications where MRI is the absolute method of choice in diagnosis and current lack of device that prevented the correct diagnostic algorithm implementation. It would also open the possibility to even more effective prevention during to ionizing radiation exposing. The basis of prevention in radiology is the existence of a proper medical indication for appropriate radiological exposures. Whenever possible it would be selected for that purpose a modality which excludes the use of ionizing radiation- Ultra Sound (US) or MRI.

MR imaging provides extraordinary soft tissue visualization and it is irreplaceable procedure in detection of lumbar stenosis, so it's a method of choice in cases of spine soft tissue injuries- bone marrow, spinal cord, intervertebral damages (sequestration, hernia), with additional possibilities of simultaneously provides views in all three planes (sagittal, coronal, transversal) and all of that without ionizing radiation exposure [7].

The rule is that diagnosis should be obtained in the shortest way with the least radiation exposure and the least cost, but not at the expense of the speed or quality of the diagnosis made. Especially it would have an effect on the categories of patient most sensitive to the effects of ionizing radiation- children, pregnant women, both genders in reproductive age and elderly patients. We should find similar examples following EBM guidelines.

One of the studies which deal with the limited MRI procedure introduction and by comparison with conventional, detailed procedures is a study from

1996 [8]. Rapid scans of the limited MRI L/S protocols lasted only 2,5 minutes compared to the conventional even 28 minutes. Limited MRI procedures would be preferable to introduce at UCC Tuzla. Saving time and money would show in the short term the justification for their introduction. Robertson's study shows: limited protocol is in 78% cases resulted in confirmation of the diagnosis of the presence/absence of IV-disc abnormality; in herniated disc the diagnosis coincident in 91% cases as in the case of disc protrusion in 84%. All second and third degree disc protrusions as well as disc herniations were confirmed by limited protocol. Minor disc abnormalities, minor changes on the fast joints and nerve root compression were better visualized by detailed protocol.

So, rapid scans of the limited MRI protocols (T2W FSE sag and T2W FSE tra) with 2,5 minutes duration, proved to be adequate in detection of potential significantly degenerative conditions of the lumbar spine. Including preparing procedure time, it is about 10-15 minutes, which excludes the usual fact about duration of MRI of more than 30 minutes [8].

Getting second, new MRI device would also help reduce the risk of cancer as the most extreme consequence of exceeding the permitted doses of radiation. It is manifestly under-actualized problem of increasing doses of ionizing radiation which patients are exposed year after year and the consequent increasing risk of cancer induction [9,10,11,12]. The fact that radiation doses are accumulated, not been released for many years, and the moment there are no record data of this in our country.

Specifically, it is about accumulative radiation doses of over 50 mSv for children and 100 mSv for adults which also carry a linearly increasing risk of radiation-induced carcinogenesis [11]. To understand the severity of problem, we will mention about interesting Brenner's study [9] which shows warring data: in 1980 3 million CT scanning were conducted in United States (US), compared to 62 million in 2006. In addition, the percentage of patients who received high and very high doses of radiation (20-30, even to 50 mSv) doubles every year [11]. Also, a report published in 2009 by the National Council on Radiation Measurement and Protection states that radiation exposure has increased by more than 600% in the last three decades. Above mentioned research [9] provides data on the incidence of 2-3% new cancer patients in comparation to the number of annual examinations performed.

Although getting a new MRI device would initially represent a major financial expense, it would be economically and medically justifiable in the near future both due to the development of patient's awareness of the harmfulness of ionizing radiation and the trend in growth need for all radiological diagnostic procedures.

This study shows that is necessary to find new sources of funding in healthcare. From an economic point of view purchasing new MRI device, even in short term, results to financial savings and improvement of the institution's market position of healthcare providers through "goodwill". On the other hand, the diagnostic results that would be provided by additional MRI procedures would help to detect the cause of disease in their initial stage. We also reduce the costs of diagnostics and treatment, expensive chemotherapy whose effects on bone tissue is questionable, hospital staying costs and more importantly expel the patient from a state of functional restriction as soon as possible and provide him conditions for an extended life quality.

From the patient's point of view, the advantage would be exposing to lower doses of radiation or none radiation. Consequently, there are less staff exposure by avoiding huge doses of secondary radiation. It would also save time in diagnosing and initiation of appropriate therapy which would immeasurably improve the patient's psychophysical status.

By the study we have emerged to approve that a different approach to financing issues can bring multiple benefits both to healthcare users and providers- through savings and financial terms which open up opportunities to allocate that funds and through increased customer satisfaction with the service provided. That would be a particularly desirable addition to the institution's portfolio.

Therefore, we also expect that the results of this study could be practically used at UCC Tuzla.

CONCLUSIONS:

1. It has been proved that there are financing options of new MRI device procurement that would be cost effective for a period less than 3 years;

2. In a short time period, the increasing participation of the economic profession in the health sector will prove as necessary;

3. Increasing such participation would aim to advice on alternative options and leave the final choice to the healthcare profession;

4. To avoid the misconceptions it is the most important to understand the goal of economic evaluation correctly- to avoid or minimize inefficient disposal of healthcare resources, not as just a simple cut in health costs;

5. The necessity of a new MRI device procurement is an evident fact;

6. The undertaken CBA shows some of financing options for the abovementioned investment project.

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