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RISK – CASH-FLOW EVALUATION OF THE E-HEALTH IMPLEMENTATION PROJECT IN THE SLOVAK REPUBLIC

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Abstract

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The aim of this paper is to present a risk-cash flow evaluation of the E-Health/Health-IT implementation project in the Slovak Republic. The paper is focused on the economic modelling in the E-Health environment. The costs of E-Health implementation in Slovakia, as demonstrated by foreign examples and studies, are expected to be overrun by cumulated benefits in medium to long term.

The processes in the investment activities are characterized by different alternative cost and/or benefit entries in terms of financial inputs and outputs. Four computer simulations based on the Latin Hypercube sampling method are applied to evaluate potential financial effects of events with a respective likelihood of occurrence. Based on the E-Health cost-benefit analysis (CBA), the probability distributions of the Net Present Value (NPV), as one of the basic indicators of measuring the investment efficiency, will be simulated, calculated and discussed. A successful development and implementation of electronic healthcare services are subject to an effective application of robust investments which cover these activities. The paper proves the idea of a seamless project implementation as a precondition for ensuring the health IT project's sustainability and profitability in the long term.

Keywords: E-Health, Cost-Benefit Analysis, simulated evaluation, Latin Hypercube sampling method, Net Present Value

INTRODUCTION

E-Health is a term which has gone into a widespread use approximately at the turn of the millennium (Aanesena, M. *et al.*, 2010; Eysenbach, G., 2001) with the burgeoning role of information and communication technologies (ICT) in delivering health care in the form of electronic health records, electronic prescriptions, electronic transfer of laboratory results, etc.

The term E-Health, or electronic healthcare services, is used to characterize the field of the so-called internet medicine; i.e. the application of ICT for health.

A great deal of influence in the E-Health implementation is attributable to the ineffective and inefficient clinical procedures, still done as paperwork. An increasing amount of medical and/or clinical errors resulting from the lack of information often leads to harming the patient, or endangering his life in the worst scenario.

Moving to paperless form of communication processes in healthcare sector, as demonstrated by earlier examples (McGinnis, J. M., 2001), is expected to make also financial contributions in form of benefits since health care costs for treating preventable diseases account for 70% of total healthcare spending (Heffler, S. *et al.* 2005),

E-Health benefits. Summarizing evidence based on several other studies, explains in detail that understanding the health flows is an indispensable precondition for identifying the potential benefits resulting from introduction of E-Health applications

(Bannick, R. *et al.*, 1995; Empirica, 2005; Glasgow, R., 2007).

Benefits resulting from the electronic way of health flows in health care are manifold – both quantitative and qualitative (Aanesena, M. *et al.*, 2010; Frisse, M. E. *et al.*, 2007). The most important benefits are a) reduction of duplicate health examinations (Rathlev, N. *et al.*, 2007; Aanesena, M. *et al.*, 2010); b) reduction of prescriptions – closely related to the duplicate medicines which should not have been prescribed because the patient is already in possession of them; c) cost reduction in the wake of mistakes and errors (FCG, 2003; European Commission, 2004; Gartner, 2009) from preventable rehospitalisation (Dansky, K. H. *et al.*, 2009; Rathlev, N. *et al.*, 2007; Seiford, L., 1997), redundant examinations (Gartner, 2009), drug interactions – reduction in adverse drug events in the wake of consumption of drugs which should not have been prescribed on account of an interaction(s) with another medicine (Aahern *et al.*, 2006; Babeľa *et al.*, 2008), law suits; d) time reduction for administrative services (European Commissoin, 2004); e) better allocation of scarce resources with health care professionals, and other.

There are many other indirect benefits resulting from E-Health implementation incl. financial (in the insurance system), healthcare (reduction of morbidity and mortality), social (in terms of social disparities, social cohesion, especially in remote and thinly populated areas), budgetary on the national level.

MATERIALS AND METHODS

Project background of E-Health implementation in Slovakia. The Slovak implementation program (2008–2018), largely financed from the EU structural funds, is divided into two main stages, each with one central and several supporting sub-projects. Currently, the first stage is being realized which aims at making the basic electronic health services available for both health care professionals, citizens and other stakeholders (e.g. insurance companies) in the healthcare system. The first E-Health stage focuses on computerization of these domains: a) E-Prescribing/E-Medication – i.e. making the process associated with medical prescriptions paperless; controlling process of medicines; b) Electronic health records (EHR)[1] c) E-Referrals, E-Booking (E-Allocation) – providing a more effective management of time and resources related to the provision of health care, and d) National Health Portal – providing relevant health-related information (healthy lifestyles, health best practices, etc.). The key and most profitable E-Health applications are electronic health records and electronic prescriptions and medication (compare Hillestad *et al.*, 2005).

Quantitative risk-oriented studies are considerably missing in the (E)health research despite the robustness of the (E)health investments (European Commission, 2008), and their impacts. Understandably, with the gradual implementation of E-Health services, investment-driven aspects of E-Health have been gaining the attention in this field.

Every investment occurs in an environment characterized by several decision variants, alternative and estimated future costs and benefits, and other inputs and outputs with likelihoods of occurrence based e.g. on historical observations. Therefore, for instance, we can assume how many E-Referrals or E-Prescriptions might be issued in different time periods (e.g. during a year) later with E-Health system implemented, how many adverse drug events occur after consumption of a medicine as a result of patient's medical misinformation, or what percentage of running cost of an E-Health application is going to be realized, etc.

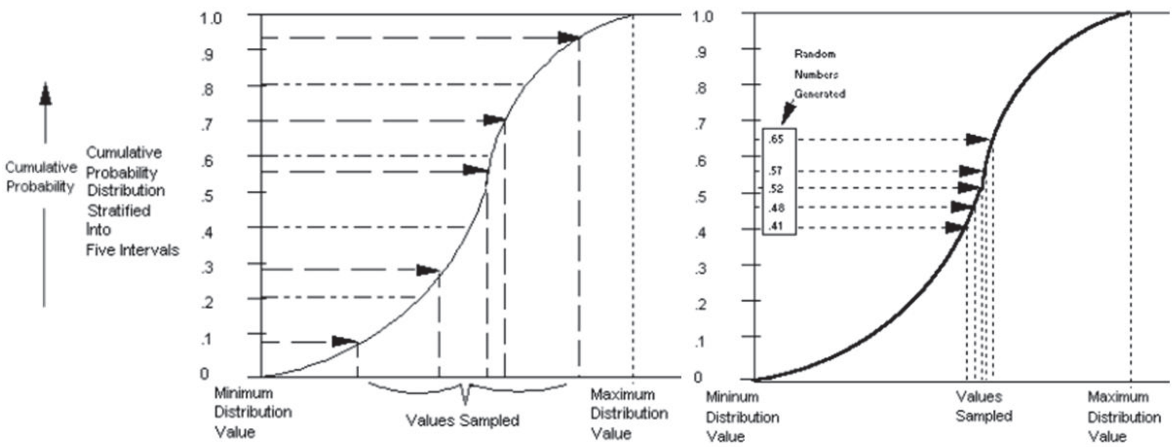
Taking this approach into account, in order to combine the static CBA analysis based on a discount factor with probability functions, sampling methods like Monte Carlo and Latin Hypercube, are among the best solutions to apply. (Varcholová, T., Dubovická, L., 2008).

When identifying the inputs and outputs, i.e. when quantifying the costs and benefits in the period 2010–2012, several perspectives had to be linked to subject the input and output variables to an evaluation. (Empirica *et al.*, 2005; Empirica, 2004) Benefits were defined as financial impacts of the interventions concerned, i.e. resulting from changing the form of information flows through computerization. The benefits were measured as reduced inefficiencies in the form of duplicate, fraudulent and erroneous prescriptions and examinations (in form of laboratory tests, x-rays, etc.) respectively as estimates which are measured on samples by Slovak health care insurance companies at least on a yearly basis.

Thanks to the sampling method, we make the inputs variable with their probabilities of occurrence, and therefore all the other input/output values based on these inputs, when counting the project profitability with NPV or internal rate of return (IRR) indicators for instance, might also be calculated in the form of results with the given probabilities rather than as static values when compared to traditional application of static calculation procedures.

Sampling methods. Monte Carlo and Latin Hypercube sampling (LHS) methods are based

1 In its basic form comparable e.g. to the already partly implemented Czech health records "IZIP – Elektronická zdravotní knížka" URL: <http://www.izip.cz>.
EHRs are by far one of the biggest contributors to benefits within E-Health (system) (Aanesena, M., 2010).



1: *Five sampling iterations of Monte Carlo (right) and Latin Hypercube (left) sampling methods*
Source: Palisade Corporation (2010); Varcholová, Dubovická (2008)

on randomness (ROSS, S., 2006), i.e. any output sample may fall from within the given distribution. See the Fig. 1 of a cumulated distribution where each number is sampled randomly within 0 and 1. We can see that five numbers have been randomly selected close to each other in the case of the Latin Hypercube as seen on the left graph of the Fig. 1. A potential crowding problem with Monte Carlo method presented on the right graph of the Fig. 1 might arise, which is a state when sampled numbers are not fully represented by the underlying distribution.

Latin Hypercube sampling, used in calculating the results of this paper, is an improved technique of Monte Carlo. The most known software solutions for LHS application include Crystal Ball® and @ Risk®[2] – the latter used for data analysis presented in this article. For more on the methods refer to the scientific literature. (Melnick, E., 2008; Robert, C., 2004; ROSS, S., 2006; Varcholová, T., 2008; Weisstein, E., 2002).

In our analysis the number of 100 000 iterations has been used, so the distribution of our functions was vertically divided into 100 000 intervals, so random numbers were chosen from each interval. With the LHS we got a better representation of data based on the underlying distributions defined in inputs which were selected as uncertain. It means that these inputs have an associated degree of uncertainty represented by the given distribution that we had pre-selected. Each of the distributions defined for a given uncertain input describes a certain set of possible future input values in time, and is replaced by one fixed value chosen by the sampling method (LHS) in each iteration. We will demonstrate this further in more concrete examples.

E-Health Cash flow in the environment of the Slovak Republic. The dataset, upon which our CBA is based, has been assembled during a period of one year, and is incessantly being updated in relation to the new fundamentals during the E-Health project implementation.[3] The dataset extends through the period of 11 years with individual projected cost and benefit inputs. There are some underlying assumptions such as number of fraud prescriptions based on estimates of Slovak health insurance companies, number of health care professionals using the Slovak E-Health information system once this is implemented in future, etc. Understanding the processes behind the E-Health implementation is fundamental in the analysis.

Since the underlying dataset is robust and extensive and cannot be presented here, the following Tab. I illustrates the fundamental Cash-Flow Analysis of the underlying dataset with total costs and benefits of four E-Health domains[4], Cash Flow (CF)/balance and Cumulative Cash Flow (CCF) in 2010 through 2020. All inputs are based on the CBA analysis, expressed in monetary values (millions of euros) in electronic prescriptions (E-Prescription), Electronic Health Records (EHR),

2 @Risk for Microsoft Excel; Risk analysis and simulation Add-in for MS Excel by Pallisade Corporation. URL: <http://www.palisade.com/>.

3 Some underlying basic data, some of which are presented in Tabs. I and II, may be found on the Slovak official E-Health information portal on URL: <http://www.ezdravotnictvo.sk/Documents/NZIS.pdf> or <http://informatizacia.sk/index/open_file.php?ext_dok=13237>. The whole CBA has been assembled on data inputs from Slovak health insurance companies, National Health Information Center (URL: <http://www.nczisk.sk>.), and Ministry of Health of the Slovak Republic (URL: <http://http://www.health.gov.sk/>). The whole CBA is available to the authors of the paper.

4 The E-Health domains and their benefits were partly discussed above, or can be alternatively found in the studies cited here.

I: *Elementary cash-flow analysis of E-Health system in Slovakia*

[€ mil.]	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Total costs	6.7	15.0	36.2	34.5	14.5	10.5	10.5	11.1	10.8	10.8	10.9
Total CAPEX	6.7	15.036	31.535	23.875	3.918	0	0	0	0	0	0
Total OPEX	0	0	4.688	10.654	10.536	10.452	10.544	11.124	10.820	10.848	10.944
1.1 e-Prescription	2.364	5.307	12.641	11.620	4.506	3.069	3.076	3.255	3.122	3.107	3.115
1.2 EHR	1.575	3.535	8.420	7.739	3.001	2.044	2.049	2.168	2.079	2.069	2.074
1.3 E-Health portal	0.789	1.772	4.221	3.880	1.505	1.024	1.027	1.087	1.042	1.037	1.040
1.4 e-Referrals	1.970	4.421	10.940	11.288	5.441	4.314	4.391	4.612	4.574	4.634	4.714
2. Total benefits	0.0	0.0	0.2	10.4	32.4	52.1	63.8	75.1	86.2	97.5	109.1
2.1. e-Prescription	0	0	0.219	9.933	27.705	42.879	53.908	64.898	75.888	87.136	98.578
2.2 EHR	0 €	0 €	0 €	0.493	4.664	9.243	9.853	10.164	10.266	10.369	10.472
BALANCE (CF)	–6.7	–15.0	–36.0	–24.1	17.9	41.7	53.2	63.9	75.3	86.7	98.1
CUMULATIVE (CCF)	–6.7	–21.7	–57.7	–81.8	–63.9	–22.3	31.0	94.9	170.2	256.9	355.0

Source: Self-assembly. Internal sources of the Ministry of Health of the Slovak Republic

II: *Some selected derived assumptions. Self-assembly. Internal sources of the Ministry of Health of the Slovak Republic*

[%]	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Savings from fraudulent prescriptions	0.00	0.00	0.01	0.68	1.59	2.09	2.60	3.10	3.61	4.11	4.62
Savings from unnecessary duplicate prescriptions	0.00	0.00	0.00	0.07	0.51	1.15	1.47	1.77	2.06	2.35	2.64
Savings from duplicate examinations	0.00	0.00	0.00	0.14	1.28	2.51	2.65	2.71	2.71	2.71	2.71
Effectiveness of elimination of duplicate and unnecessary prescriptions	0	0	10	67	90	90	90	90	90	90	90
health care providers connected	0	0	3	70	90	93	95	95	95	98	99
citizens connected	0	0	6	19	32	42	52	62	72	82	93

and in introducing the E-Health portal. Total capital expenses (CAPEX) and operational expenses (OPEX) of health care institutions, health insurance companies, and health care professionals are also summarized. The Tab. II illustrates some selected important assumptions which are expected to be realized when E-Health implementation gradually proceeds in time.

On these data, the actual cost and benefit inputs have been evaluated. The data for the first three time periods (years 2010 to 2012) are real, and hence certain, so they do not need to be represented by any distribution. First E-Health benefits were expected in 2013.[5] As for the future values, we defined distributional (functional) behaviour of possible future occurrence or non-occurrence for two following fundamental inputs. Based on the rough estimates of governmental predictions, the distributions were selected and defined. This demonstrative selection and definition aims at incorporating the risk factors while trying to dynamically capture the real possible occurrence of future events. These defined distributional inputs, as we explain further, are really essential for a well-functioning E-Health system because without them only few financial, socio-economic, etc. benefits from E-Health would materialize.

There are two crucial factors entering whatever E-Health implementation design of any country, which is the measure of connectedness of health care providers on one side and citizens (patients) on the other. (Wang, S. *et al.* 2003) Without any of these two key stakeholders, the E-Health system would be hardly functioning, or only on a very limited basis. This is why we focused our simulations on these two groups. There were two underlying functions selected from the set of functions predefined in @Risk® 6 which had to be selected after due consideration, and which consisted in judging the suitability with the function's parameters to be defined so as to best reflect the future reality. There were no previous studies found which would support the selection of these pre-defined functions in the software to predict the future. On the other hand, cumulative and triangular functions which were selected are easily definable in the software,

5 However, a short suspension of the project due to political decision in 2011, 2012, and again in 2013 postponed the realization of benefits further in time, which has not been incorporated in this study since we focus on basic risk Fundamentals.

2: *Cumulative function of E-Health integration of health care professionals in 2012*
Source: Self-assembly in software @Risk® 6

III: *Parameters and distribution functions of the cumulative distribution*

Parameters	min	continuous parameter min < max
	max	continuous parameter
	$\{x\} = \{x_1, x_2, \ldots, x_N\}$	array of continuous parameters $\min \le x_i \le \max$
	$\{p\} = \{p_1, p_2, \ldots, p_N\}$	array of continuous parameters $0 \le p_i \le 1$
Density and Cumulative Distribution Functions	$f(x) = \dfrac{p_i - p_{i+1}}{x_{i+1} - x_i}$	for $x_i \le x < x_{i+1}$
	$F(x) = 1 - p_i + (p_i - p_{i+1})\left(\dfrac{x - x_i}{x_{i+1} - x_i}\right)$	for $x_i \le x \le x_{i+1}$
	With the assumptions: The arrays are ordered from left to right The i index runs from 0 to N + 1, with two extra elements: $x_0 \equiv \min$, $p_0 \equiv 1$ and $x_{N+1} \equiv \max$, $p_{N+1} \equiv 0$.	

Source: @Risk® 6 Help. See also Palisade Corporation (2010)

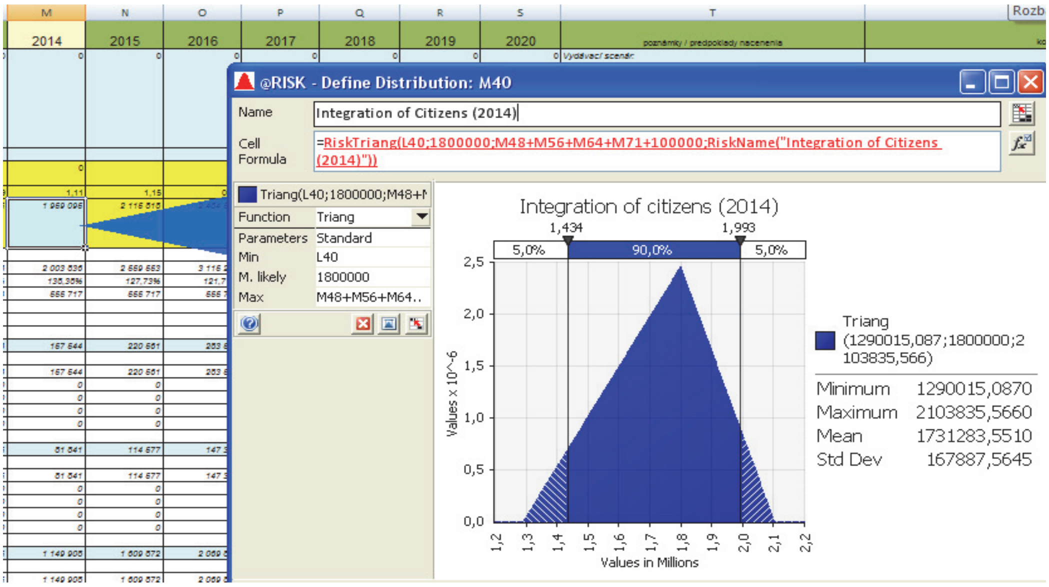
and are expected to reflect the real present and future patterns. Each function has its own parameters to be entered. The function itself is then displayed and simulated by the software solution. This is one of the key reasons why computer-based simulations for future predictions is ever more popular and used. The model can be incessantly updated throughout the life cycle of the project.

1) *Percentage of health care professionals with E-Health system integrated in their work environment.*

Rather than governmental predictions relying on the exact percentage of health care professionals integrated into the E-Health system[6], a distribution function has been defined throughout the 8 years.

The prediction of 4%–5% integration of health care professionals in the E-Health system in 2012 has been defined by the @Risk's Cumulative Distribution as the maximal possible value of 5% in that year, predicted also by the government. The minimal value was set to 2%. The probabilities were set deliberately so as to reflect the fact that

6 This assumption proved to be real since in 2012 the first 4% of healthcare professionals should have been connected to the E-Health system which did not happen. Similarly, for a period of approximately one year, the E-Health implementation in Slovakia was stopped, postponing thus the pre-defined assumptions, not really accounted for previously, forward in time.



3: *Triangular distribution of integration of citizens via e-Cards in 2014.*
Source: Self-assembly in software @Risk® 6.

IV: *Parameters and distribution functions of the triangular distribution*

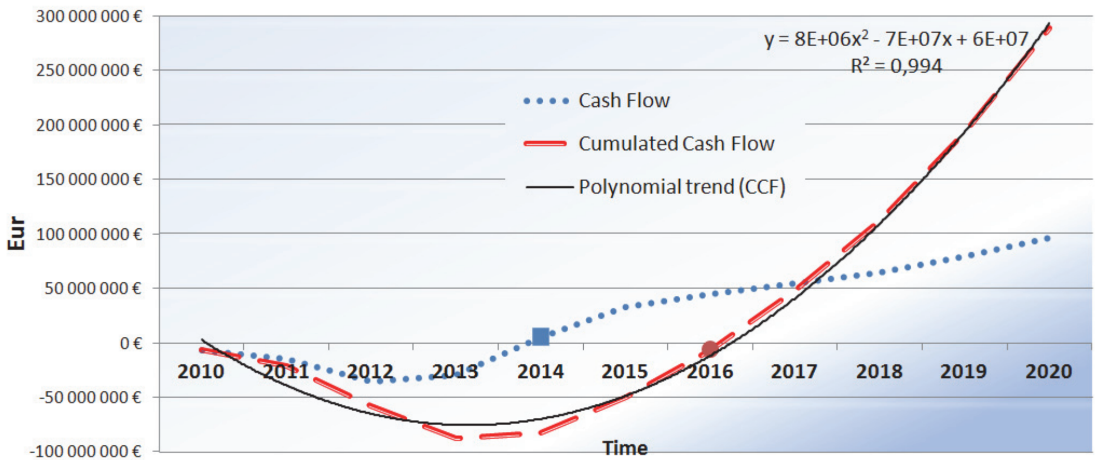
Parameters	min	continuous boundary parameter min < max *
	m.likely	continuous mode parameter min ≤ m.likely ≤ max
	max	continuous boundary parameter
	*min = max is supported for modelling convenience, but gives a degenerate distribution.	
Density and Cumulative Distribution Functions	$f(x) = \frac{2(x - \min)}{(m.likely - \min)(\max - \min)}$	min ≤ x ≤ m.likely
	$f(x) = \frac{2(max - x)}{(max - \text{m.likely})(\max - \min)}$	m.likely ≤ x ≤ max
	$F(x) = \frac{(x - min)^2}{(m.likely - \min)(\max - \min)}$	min ≤ x ≤ m.likely
	$F(x) = 1 - \frac{(max - x)^2}{(max - m.likely)(\max - \min)}$	m.likely ≤ x ≤ max
Variance	$F(x) = \frac{min^2 + m.likely^2 + max^2 - (\max)(m.likely) - (m.likely)(\min) - (\max)(\min)}{18}$	

Source: @Risk® 6 Help. See also Palisade Corporation (2010)

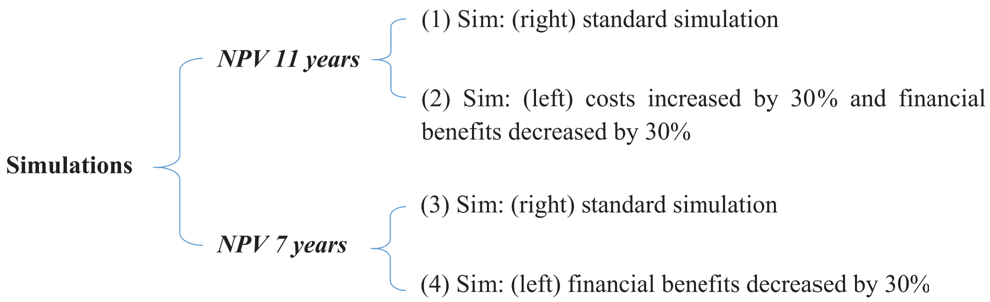
up to 60% (difference of probabilities 1.0 and 0.4 on the y-axis) no more than 3% (x-axis) of health care professionals will be connected. The first part of the curve (from 2% to 3% on the x-axis) shows a steeper slope of the curve since, judging by the y-axis, this is the most probable area. In other words, the slope reflects the fact that most probably up to 3% of doctors are expected to be connected. The parameters of the distribution for the following remaining years were set similarly and deliberately through specified conditional formulae, i.e. based on the randomly sampled number in the previous year in order that no lower number than that of the previous year could be sampled. This is understandable since the integration of doctors will be continuous in time. See the Fig. 2.

The parameters and function are mathematically described in the following Tab. III.

The @Risk RiskCumul function (*minimum, maximum*, $\{X_1, X_2, \ldots, X_n\}$, $\{p_1, p_2, \ldots, p_n\}$) specifies a cumulative distribution with *n* points. The range of the cumulative curve is set by the minimum and maximum arguments. Each point on the cumulative curve has a value *X* and a probability *p*. Points on the cumulative curve are specified with increasing value and decreasing probability. Probabilities entered are cumulative descending probabilities, or the probability



4: *Cash flows and cumulated Cash flow of E-Health CBA.*
Source: Self-assembly.



5: *Four simulations of the E-Health implementation based on the CBA analysis.*
Source: Self-assembly.

of a value greater than the entered X value. Any number of points may be specified for the curve. The values were set as explained in the previous part of this chapter.

2) *Number of citizens with electronic identification card to be used in Slovak healthcare.*

Similarly, we defined a triangular distribution to predict the future possible and real values (Fig. 3). The distribution has a number of desirable properties of real world processes. These include that it is simply definable, having a bounded range. This concrete distribution is characterized by three parameters: the predicted minimum, the most likely and the maximum values. The logic of the procedure, also in terms of the following data in time, is similar like in the previous example.

The direction of the skew of the triangular distribution is set by the size of the most likely value relative to the minimum and the maximum. Some characteristics are presented in the following Tab. IV.

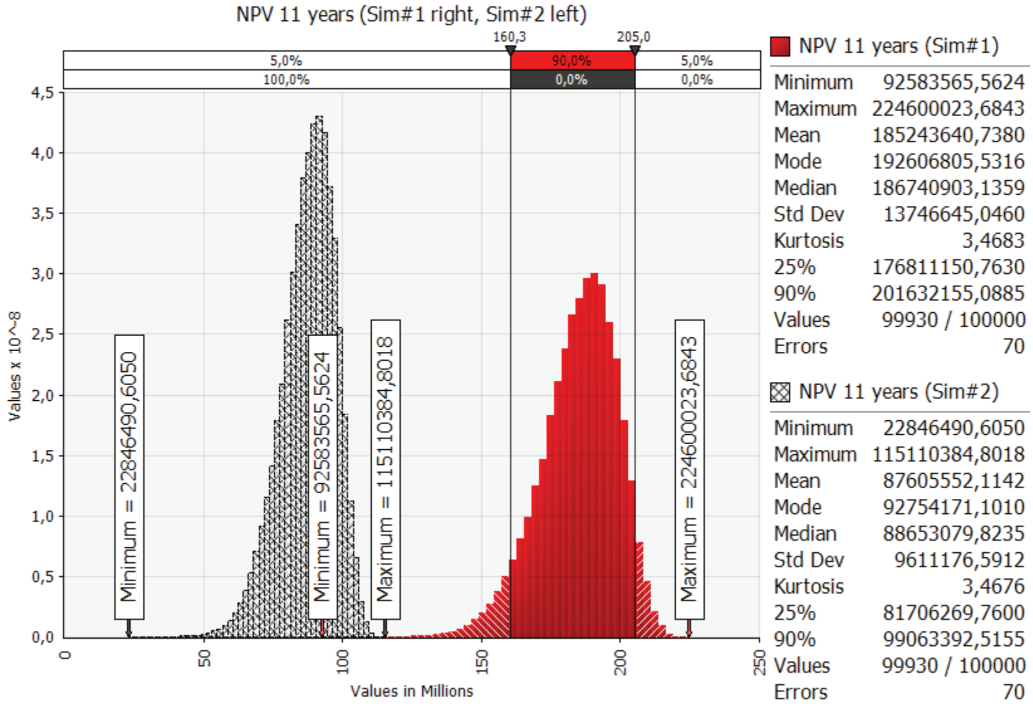
RESULTS

The results of our analysis are also presented in the form of risk curves with some statistical characteristics. Before running the simulations, we calculated the cash flows in time (based on Tabs. I–II discussed above) which are depicted in the following Fig. 4. By comparison, the Cumulated Cash Flow (CCF) line was added a polynomial trend based on the method of the Least Squares, and which can be explained by ca. 99.4 of values by the polynomial trend as the characteristic of R^2.

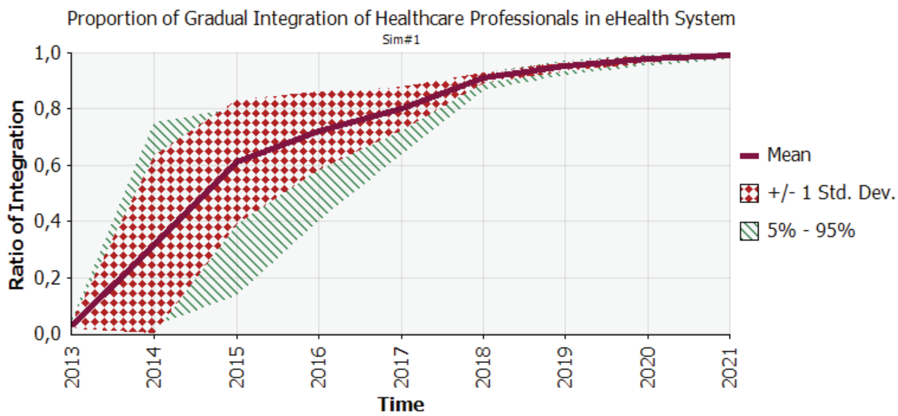
Judging by the Fig. 4, we see that it is not earlier than 2014 when benefits exceed costs if E-Health implementation proceeds according to the plan. Cumulated benefits should be significantly increasing in time if all the components and all parties are fully connected.

With the distributions of selected values set, we simulated the calculation of the NPV value of 11 years and of 7 years[7] various times with two alternatives defined in each as presented

7 We decided to simulate the NPV for 7 years (2010–2016) – coinciding with the implementation period during which the first and second E-Health stages are planned – to show what would happen if in the year of the first positive cumulative cash flow the E-Health implementation, year 2016, would suddenly be stopped in Slovakia and re-launched later or not earlier again than in 2021 for various reasons (compare Fig. 4).



6: *NPV 11 years (2 simulations).*
Source: Self-assembly as evaluated by @Risk® 6.



7: *Summary trend of percentage of health care professionals' integration*
Source: Self-assembly as evaluated by @Risk® 6

in the Fig. 5. So four simulations were run together. The first simulation of NPV was run normally. The second, though, was run under a pre-set condition of artificially increasing the running costs and decreasing the financial benefits by 30%. This value is set roughly. This approach seems to be a common method to reflect optimism bias and contingencies in models as applied in another similar study (Empirica, 2005). Similarly, to predict another negative impact, we adjusted the financial benefits when calculating the NPV for 7 years. This approach works under the assumption that the underlying benefits in the CBA analysis might be evaluated optimistically higher, and the costs optimistically lower compared to the reality in future. These adjustments of 30% as corrections should reflect this bias.

NPV 11 years

The following Fig. 6 depicts the probability distributions – results of the simulations (1) and (2). Even though the both NPVs are positive (≈ €185 mil. and €87 mil. respectively), the second NPV, Fig. 6 (left), is shifted to the left, representing thus a less profitable alternative. However, with the operating cost higher by 30% in the second simulated alternative (on the left), the minimum value decreased more significantly from ≈ €92 mil. to €22 mil. This is primarily attributable to the high benefits in the last three years when all subjects are fully integrated in the E-Health system. The supplementary table as a result of simulation is also presented. The characteristics modus, median, and other characteristics, represent the NPV values since this NPV was calculated 100 000 times.

The following Fig. 7 illustrates another risk curves depicting the summary trend (1 sim) of gradual networking of doctors to the national E-Health information system. It shows the summary trend – a type of a chart summarizing changes in multiple probability distributions or an output range. The summary Fig. 7 takes five parameters from each selected distribution – the mean, two upper and two lower band values, and shows the changes in the five parameters across the output range. The upper band values are by default equal to +1 standard deviation and the 95th percentile of each distribution, while the two lower band values are by default equal to −1 standard deviation and the 5th percentile of each distribution.

As shown in the Fig. 7, the years 2013 through 2016 are represented by relatively large intervals of IT interconnectedness among physicians. For instance, up to 60% of physicians on average are supposed to share the E-Health solutions in 2015, but it also might be 80% of them or only 10% in the adverse scenario. This is explained with a higher degree of variance in these years. It is almost certain that from 2017 to 2020 nearly all doctors should be in. Furthermore, we see that from 2014 to 2017 it is highly probable that extreme values of interconnectedness will come from lower ranges than higher, i.e. it is more likely that a lower (extreme) number of physicians will be connected than the higher as depicted in the striped range on the bottom.

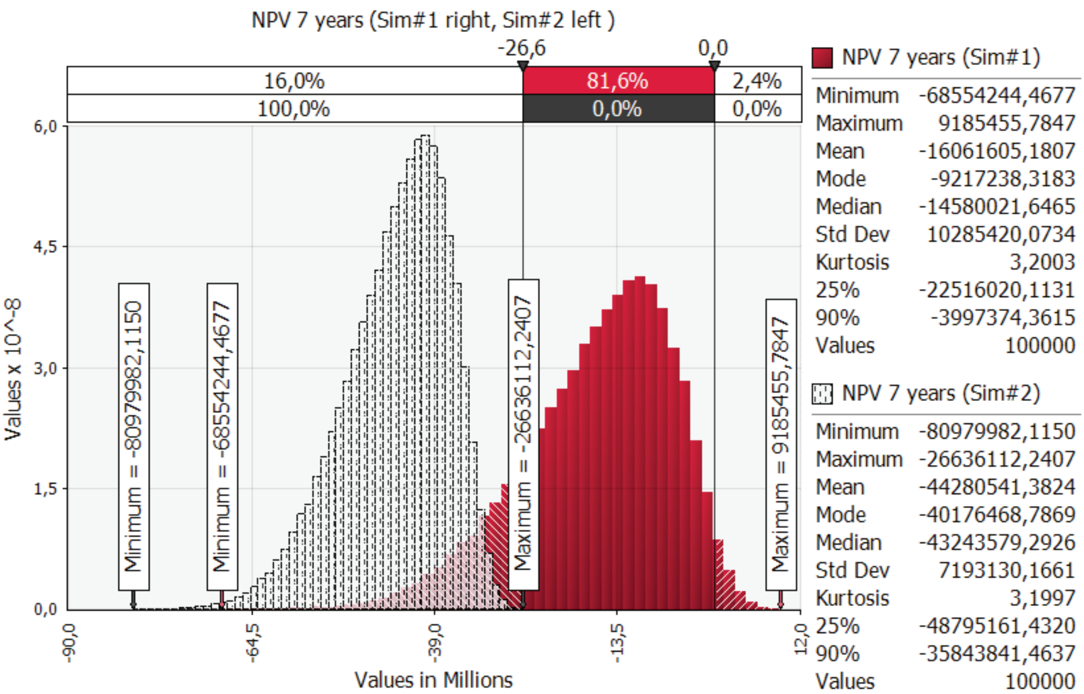
NPV 7 years.

The following Fig. 8 depicts the probability distributions – results of the simulation 3 on the right and 4 on the left. Abjuring the last three years of the E-Health implementation would not be profitable. We see that the mean of the predicted NPVs is ≈ €-16 mil. and ≈ €-44.3 mil. respectively. The NPV (3) is negative to 97.6%, so it is not desirable to start the project and have it in 7 years stopped due to e.g. political change. Moreover, with the financial benefits lower by 30% (Sim 4) and judging by the distribution behaviour of the NPV, we may say that the project is definitely, i.e. to

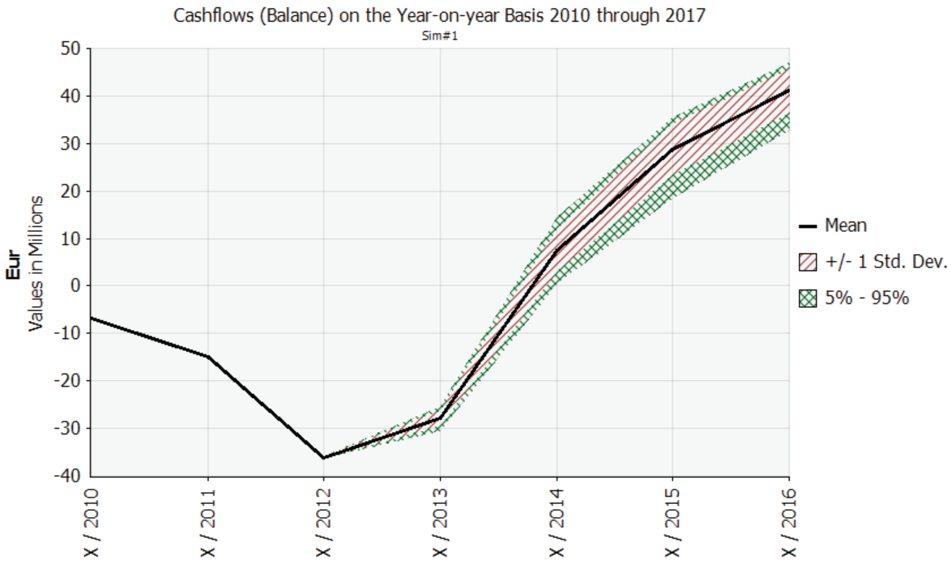
100% not profitable. This fourth simulation tells us more about a possible shift of the NPV in the negative direction if real financial benefits would not materialize as expected.

When looking on the behaviour of risk of our measured output (NPV) in Fig. 9, we see that the risk is growing in time as characterized by the increasing deviation around the mean (striped and chequered ranges) in the summary trend of Net Cash Flows on the year-on-year basis of our E-Health CBA. It is also associated with a high variability of integration of doctors (compare with the Fig. 7).

There are many other display options which could prove what is shown or indicated in previous graphs such as Tornado graphs, and other charts.



8: *NPV 7 years (2 simulations)*
Source: Self-assembly as evaluated by @Risk® 6



9: *Summary trend of Net Cash Flows in respective years*
Source: Self-assembly as evaluated by @Risk® 6

DISCUSSION AND CONCLUSIONS

The paper focuses on the basic characteristics of the risk analysis of the E-Health CBA within the Slovak E-Health implementation program. The paper does not look in detail at other factors which might be measured and analysed such as discount factor, tax policy, or other input variables, incessantly being updated in real model in relation to changing fundamentals in time. So these are some of the issues which may be subject to the further research.

The structure of the E-Health evaluation might be subjected to several methodological approaches. (Ahern *et al.*, 2006; Babeľa, R. *et al.*, 2008; Bates, D. *et al.*, 1997; Chilingerian, J. *et al.*, 1990; Croll *et al.*, 2007). In the paper, contrary to the E-Health impact study by Empirica, 2004, for instance, the present underlying CBA analysis was not summarized horizontally in the health care sector, i.e. reflecting the costs and benefits particularly for different stakeholders like citizens, health care professionals, or respective medicinal sectors such as radiology departments, intensive care units, etc. Like presented in the study by Gartner, 2004, we tried to demonstrate the connection between political goals, E-Health technologies and, contrary to the governmental static and rather optimistically biased predictions, potential predicted benefits with a certain level of risks reflected in the computations of the standard NPV value.

Furthermore, the underlying benefits and costs were from 2012 on predicted on the historical observations of trends in mainly cost of health care on the national level, drug consumptions etc. The reader must be aware of the fact that with the extending period in time, beyond 2014, predictions might be further considerably less exact and are based on constants. This is why the data must be incessantly being updated over time. The paper primarily aims at the demonstration of simulated inputs and results. Respective concrete inputs and outputs will be subject to further statistical analyses in order to make the future studies based on these simulations, and in view of quantifying the E-Health benefits in the Slovak health care setting, more exact. The methodology used can be easily used also in other settings in other countries provided that the data set, being often especially hard to procure due to the particularly more sensitive health care data, will be available.

A successful development and implementation of electronic healthcare services are subject to an effective application of robust investments which cover these activities. Therefore, many factors need to be considered, including various research approaches on both microeconomic and macroeconomic level. As expressed by several authors we have mentioned, there is a strong need of further research activities in this relatively new health area.

SUMMARY

The profitability of the E-Health implementation in the Slovak Republic in 2010–2020 has been calculated based on the CBA analysis and simulated using the Latin Hypercube Sampling Method. The cumulative capital expenses of the project as defined in the model are €81.1 mil. The cumulative costs of operation amount to €90.6 mil. The overall costs amount to €171.7 mil. The overall benefits amount to €526.7 mil. The NPV of the whole real 11 year-long project and that of the hypothetically

shortened 7 year-long project is €185 mil. and €-160.6 mil. respectively. Taking the potential optimistic bias of the real model into account, the hypothetical NPV of the 11 year-long project with yearly costs of operation increased by 30% and yearly financial benefits decreased by 30% of the hypothetical 7-year-long project, amounts to €87.6 mil. and €-44.3 mil. respectively.
The integration of doctors and citizens in the E-Health system is crucial in 2014 through 2015 and onwards since the NPV is very sensitive upon them. Thus a due focus should by paid to especially these years not only by policy makers but also IT designers from the early stages of the project planning.
Any postponement of the project since the start would be detrimental to the project financial profitability, let alone its suspension. The most important challenges predominantly assume measures of involvement and representativeness at both patient-citizen and healthcare setting levels. The key and most profitable E-Health applications are electronic health records and electronic prescriptions and medication.

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