Open Source Migration in Greek Public Sector: A Feasibility Study

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Abstract. Open Source software has been recently recognized by governments as a viable and cost effective solution. However, transition to open source is not a plug-and-play process but one that requires deep knowledge of open source dynamics and of organization's operations, budgetary constraints, capacities, ethics and political agenda. As with any IT transition, there are uncertainties and risks that need to be handled in order to maximize the gains for the organization and for the society through the provided services. In this paper we present a feasibility study conducted in 15 Greek public sector organizations with the aim to discover the value this transition brings to a typical public sector organization.

1 Introduction

The benefits of Open Source Software (OSS) within public sector (PS) have been highlighted by numerous studies [6],[12],[14],[15] focusing on the the fast growth of OSS projects and open standards which offer usable solutions able to support organizations in supplying high quality services to society. However the OSS migration is not a risk free plug and play process. According to [3], the uncertainty of the quality of the OSS applications [4], the dynamic nature of the majority of OSS projects [5] and the lack of technical support [9] are some of the obstacles faced by integrators. Furthermore, while there is an acknowledged demand for financial transparency that advocates the use of OSS, there is still lack of awareness of the feasibility and viability of OSS in the PS environment. In [13] authors argue that the majority of public sector shows little interest in financial performance.

To discover the value of OSS migration and to shed light to the uncertainties that affect its viability, we conducted a feasibility study in fifteen municipalities in Greece, where we calculated the value generated from three scenarios of OSS adoption namely *minimal*, *basic* and *massive* based on the number and type of the adopted software solutions. To do so, Real Options Analysis was employed as a decision making tool able to capture the uncertainties faced by integrators and calculate their impact on the anticipated revenues.

The paper is structured as follows. In section two we provide background information on the Real Options Theory and tools, followed by the proposed approach. In section three we analytically present the results of the study and finally we share some ideas for further research in section four.

2 Background and proposed approach

We argue that the value of an OSS is generated and both affected by its project's dynamics [7]. As the OSS evolves over time, uncertainties related with its provided qualities such as usability, availability and maintainability, may be introduced or resolved. However, to what extend these uncertainties will affect the anticipated value is subject to organization's capacities, competencies, resources and constraints. Hence, selecting the right OSS solutions (the more profitable) depends on organization's resilience to these uncertainties. In this respect, finding the more profitable migration scenario is not simply a matter of accumulating the value generated from the number of OSS solutions to be adopted but of identifying which OSS solutions maximize and/or maintain their values over time.

Real options analysis is a valuable decision making tool capable of exploring the volatility of the anticipated OSS value in order to provide reasoning about the viability of the migration scenario. Real Options Analysis (ROA) is based on the analogy between investment opportunities and financial options. A real option is a right, but not an obligation, to make a decision for a certain cost within a specific time frame. A project is perceived as an option on the underlying cash flows (value) with multiple associated investment strategies to be exercised if conditions turned out to be favorable.

As option is an asset that provides its owner the right with out a symmetric obligation to make an investment decision such as growth, exit, wait, and learning etc. If conditions to investing arise, the owner can exercise the option by investing the strike price defined by the option. A call option gives the right to acquire an asset of uncertain future value for the strike price. There are two option mechanisms, namely the *call* and *put*.

A *call option gives* the buyer of the option the right to buy the underlying asset at a fixed price, called the exercise price, at any time prior to the expiration date of the option: the buyer pays a price for this right. If at expiration, the value of the asset is less than the strike price, the option is not exercised and expires worthless. If, on the other hand, the value of the asset is greater than the strike price, the option is exercised. The net profit on the investment is the difference between the gross profit and the price paid for the call initially.

In a similar manner, a put option gives the buyer of the option the right to sell the underlying asset at a fixed price, again called the strike or exercise price, at any time prior to the expiration date of the option. The buyer pays a price for this right. If the price of the underlying asset is greater than the strike price, the option will not be exercised and will expire worthless. If on the other hand, the price of the underlying asset is less than the strike price, the owner of the put option will exercise the option and sell the stock a the strike price, claiming the difference between the strike price and the market value of the asset as the gross profit.

Many authors appreciated the applicability of ROA in IT investments like in [1],[2] while others employed ROA in software engineering practices such as in [8],[10], [11]. Following the same logic, we argue that an OSS migration scenario can be

expressed as a *call option*, where the owner (the PS organization) has the right but not the obligation to make the selection within a given time frame.

Before proceeding to the analysis we translate the traditional ROA variables to fit to our context of use. Intuitively we have:

1. Current Value (Net Present Value) of migration scenario (So): The accumulation of the costs of the operational proprietary software are the cash flows generated from the adopted OSS.
2. Exercise Price (X): Total Cost of Ownership (TCO) of the adopted OSS.
3. Time to Expiration (T): The time frame decision makers have to select the optimum migration scenario.
4. Volatility of the Underlying Asset Value (σ): The percentage of the cash flows fluctuations due to uncertainties introduced from the dynamics of the adopted OSS.
5. Risk Rate (r): The Cost of capital

Our approach employs three consecutive steps. The first step commences with the discovery of the uncertainties. In the second we calculate the expected cash flows and their associated volatilities in the form of (%) standard deviation, and finally in the third step we calculate the call options for each OSS candidate and we compare the results. We present this steps in detail through our presentation of the case study.

3 Feasibility Study on the Migration to OSS in Greek Public Sector

3.1 Study Preparation

We examined 85 of the 325 (26.15%) municipalities in Greece where we recorded all proprietary applications currently in use and categorized these according to their provided functionalities and domain:

- Administrative Applications
- Office related Applications
- Resource Planning Applications
- Operating System

After conducting interviews with IT managers we produced a list of OSS applications capable of providing the intended functionalities and group these into three migration scenarios as shown in table 1:

- ➢ Scenario 1 - Massive Change
- ➢ Scenario 2 - Basic change
- ➢ Scenario 3 - Minimal change

SOFTWARE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Office Application	OpenOffice.org	OpenOffice.org	OpenOffice.org
Operating System	UBUNTU LINUX	-	-
Protocol	SCRIPTUM	SCRIPTUM	SCRIPTUM
Document Management			
Registries Managment	OpenERP	OpenERP	-
Real Estate Tax			
Traffic code			

Water/Sewer			
Irrigation			
Payroll	OrangeHRM	OrangeHRM	
Humman Resource Management (HRM)			

Table 1: OSS applications capable of substituting the currently installed closed source applications

We then proceeded to a closer examination of fifteen municipalities (average in population size and in IT department staffing), to obtain the necessary financial data for our ROA application. For each scenario we calculated the installation and maintenance costs as shown below (all calculations are in Euros):

OSS Software	Installation Cost	Maintenance Cost	Total
Open Office	2,000	0	2,000
SCRIPTUM	12,000	5,000	17,000
Linux	11,000	5,000	16,000
ERP	15,000	5,000	20,000
OrangeHRM	15,000	5,000	20,000
Total	**55,000**	**20,000**	**75,000**

Table 2: Installation and Maintenance costs for scenario 1

OSS Software	Installation Cost	Maintenance Cost	Total
Open Office	2,000	0	2,000
SCRIPTUM	12,000	5,000	17,000
ERP	15,000	5,000	20,000
OrangeHRM	15,000	5,000	20,000
Total	**44,000**	**15,000**	**59,000**

Table 3: Installation and Maintenance costs for scenario 2

OSS Software	Installation Cost	Maintenance Cost	Total
Open Office	2,000	0	2,000
SCRIPTUM	12,000	5,000	17,000
Total	**14,000**	**5,000**	**19,000**

Table 4: Installation and Maintenance costs for scenario 3

We proceeded with calculation of costs of the currently operational proprietary software for a twenty years period. As stated before, these costs will be attributed to the cash flows generated from the adopted OSS. Similarly for each scenario we have:

Years	Proprietary Purchase Cost	Installation and maintenance cost	Total
2011	103,500.00	32,500.00	136,000.00
2012	0.00	34,125.00	34,125.00
2013	0.00	35,831.25	35,831.25
2014	36,225.00	37,622.81	73,847.81
2015	0.00	39,503.95	39,503.95
2016	0.00	41,479.15	41,479.15

2017	38,036.25	43,553.11	81,589.36
2018	0.00	45,730.76	45,730.76
2019	0.00	48,017.30	48,017.30
2020	39,938.06	50,418.17	90,356.23
2021	0.00	52,939.08	52,939.08
2022	0.00	55,586.03	55,586.03
2023	41,934.97	58,365.33	100,300.30
2024	0.00	61,283.60	61,283.60
2025	0.00	64,347.78	64,347.78
2026	44,031.71	67,565.17	111,596.88
2027	0.00	70,943.42	70,943.42
2028	0.00	74,490.60	74,490.60
2029	46,233.30	78,215.13	124,448.42
2030	0.00	82,125.88	82,125.88
Total	349,899.29	1,074,643.51	1,424,542.80

Table 5: Cash flows from migration scenario 1

Years	Proprietary Purchase Cost	Installation and maintenance cost	Total
2011	98,500.00	28,500.00	127,000.00
2012	0.00	29,925.00	29,925.00
2013	0.00	31,421.25	31,421.25
2014	34,475.00	32,992.31	67,467.31
2015	0.00	34,641.93	34,641.93
2016	0.00	36,374.02	36,374.02
2017	36,198.75	38,192.73	74,391.48
2018	0.00	40,102.36	40,102.36
2019	0.00	42,107.48	42,107.48
2020	38,008.69	44,212.85	82,221.54
2021	0.00	46,423.50	46,423.50
2022	0.00	48,744.67	48,744.67
2023	39,909.12	51,181.91	91,091.03
2024	0.00	53,741.00	53,741.00

2025	0.00	56,428.05	56,428.05
2026	41,904.58	59,249.45	101,154.03
2027	0.00	62,211.93	62,211.93
2028	0.00	65,322.52	65,322.52
2029	43,999.81	68,588.65	112,588.46
2030	0.00	72,018.08	72,018.08
Total	332,995.94	942,379.69	1,275,375.64

Table 6: Cash flows from migration scenario 2

Years	Proprietary Purchase Cost	Installation and maintenance cost	Total
2011	18,500.00	10,000.00	28,500.00
2012	0.00	10,500.00	10,500.00
2013	0.00	11,025.00	11,025.00
2014	6,475.00	11,576.25	18,051.25
2015	0.00	12,155.06	12,155.06
2016	0.00	12,762.82	12,762.82
2017	6,798.75	13,400.96	20,199.71
2018	0.00	14,071.00	14,071.00
2019	0.00	14,774.55	14,774.55
2020	7,138.69	15,513.28	22,651.97
2021	0.00	16,288.95	16,288.95
2022	0.00	17,103.39	17,103.39
2023	7,495.62	17,958.56	25,454.19
2024	0.00	18,856.49	18,856.49
2025	0.00	19,799.32	19,799.32
2026	7,870.40	20,789.28	28,659.68
2027	0.00	21,828.75	21,828.75
2028	0.00	22,920.18	22,920.18
2029	8,263.92	24,066.19	32,330.12
2030	0.00	25,269.50	25,269.50
Total	62,542.39	330,659.54	393,201.93

Table 7: Cash flows from migration scenario 3

3.2 Applying Real Options Analysis

From the collected information we where able to calculate the total budget assuming a two year period within which all employees will operate the adopted OSS solutions:

Total Budget		
Scenario 1	**Scenario 2**	**Scenario 3**
99,850	80,550	24.700

Finally the Net Present Values with 10% cost of capital was found:

Net Present Value		
Scenario 1	**Scenario 2**	**Scenario 3**
134,001	169,445	42,199

To estimate the volatilities we took into account the following factors affecting the expected cash flows for each scenario:
- Popularity of the OSS to be adopted
- Awareness of the OSS from employees
- Dependency of the substituted proprietary application with legacy applications

Based on the scores and weights provided by the IT managers we obtained a 30%, 20% and 10% volatility estimations for the three scenarios respectively.

With risk rate at 10% and Time to expiration 4 years (the time frame to select one of the three scenarios) we have:

Net Present Value	134,151.08
Exercise Price	99.850,00
Time to Option Expiration	4 Years
Risk rate	10,00%
Volatility	30,00%

Table 8: Data for ROA - scenario 1

Net Present Value	169,445.39 €
Exercise Price	80.550,00 €
Time to Option Expiration	4 Years
Risk rate	10,00%
Volatility	20,00%

Table 9: Data for ROA - scenario 2

Net Present Value	42,20 €
Exercise Price	24.700,00 €
Time to Option Expiration	4 Years
Risk rate	10,00%
Volatility	10,00%

Table 10: Data for ROA - scenario 3

To calculate the Option Values C_0 we employed the Black-Scholes model given as :

$$C_{0 =} S_0N(d_1)-Xe^{-rT}N(d_2) ,$$

where:

$$d_1 = [\ln(S_0/X)+(r+\sigma^2/2)T]/\sigma\sqrt{T},$$

$$d_2 = d_1 - \sigma\sqrt{T} ,$$

and N(d) is the probability that a random draw from a standard normal distribution will be less than (d). Employing available Option Value calculators[12] we finally obtained:

Options Values		
Scenario 1	Scenario 2	Scenario 3
70,845.18	115,471.65	25,642.09

These option values represent the additional value that comes from the right not to implement immediately the migration scenario but only upon favorable conditions. Going a step further Option Value C_0 depends on two variables, the Intrinsic Value (IV) and the Time Value (TV), as such,

$$C_0 = IV + TV,$$

The intrinsic value (IV) of an option is the value of the option if exercising it now and is given as:

$$IV = S_0 - X,$$

Intrinsic value can be defined as the amount by which the exercise price of an option is "in-the-money". It is actually the portion of an option's price that is not lost due to the passage of time. While Time Value or "Option Premium" give as:

$$TV = OV - IV,$$

is the real cost of owning a stock options contract. It is the part of the price of an option which the seller of the option gets to keep as profit should the stock remain

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[1] http://www.soarcorp.com/black_scholes_calculator.jsp

[2] http://www.soarcorp.com/black_scholes_calculator.jsp

inactive until its expiration. In our context Time Value is the amount of money the PS organization will loose by waiting to see how the uncertainties associated with the migration scenario will evolve over the time to expiration. Calculating the option premiums for the three scenarios we have:

	Option Premium
Scenario 1	36,694.10
Scenario 2	26,576.26
Scenario 3	8,143.09

What we can infer is that the third scenario is the one with the lowest cost of waiting. Nevertheless, the second scenario is the one that should be preferred as not only provides the highest Net Present Value but also a lower cost of waiting (option premium) in comparison to the first scenario.

4 Conclusions

We have presented an options based approach for the valuation of the OSS migration in a PS organization. The application of ROA addresses some fundamental issues, like the lack of accountability and risk averseness inherent in PS environments. The method provides an alternative view to the OSS migration process in the uncertain Open Source Software realm. By perceiving the OSS migration as a risky investment, a more accurate calculation of the anticipated value of OSS employment to PS environments can be achieved. It is our intention to extend this study to other public sector organizations and to examine the suitability and applicability of simulation techniques i.e. Monte-Carlo in volatility calculations.

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