

Cost Efficiency Calculation and Analysis for Business Processes Transformation to Cloud Computing Systems Architecture

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Abstract—Although much has been discussed that cloud computing solutions provide a number of key benefits for enterprises which decide to apply it, however, there is a lack of a certain pattern, which could help enterprises to decide whether the architectural transformation to cloud computing solution will be economically viable. Mathematical calculations and various setting methods of identifying and calculating the costs of applying the cloud is becoming a new challenge. Owing to lack of investigative studies explaining the cost efficiency for business process transformation to cloud computing systems architecture to ensure the economic justification of the transition taken, this paper is to identify the costs of transformation to cloud computing systems architecture, outline cost efficiency method/s, and create a calculation and analytical tool that could be useful for enterprises and decision makers, and use it to assess if transformation to cloud solution was economically beneficial and cost efficient for Riga City Council.

Keywords-cloud; cost efficiency methods; efficiency and costs calculation

I. INTRODUCTION

Cloud computing is the future of computing technology. Cloud development has a potential to completely change how Information and Communication Technologies (ICT) companies render services to their customers by using technologies. ICT enterprises know that cloud computing is able to deliver ICT services efficiently and cost-effectively and has many advantages: easy implementation, qualified staff, and scalability, making internal resources available and enabling enterprises to improve the quality of their services. Cloud computing reduces the cost of ICT services and decrease processing time while increasing reliability, availability, processing capacity and flexibility [5]. According to different reports, the revenue from cloud computing is estimated in billions of euro and the global cloud computing market will reach €193 billion in 2020 [1][7][13].

The challenge arises when making a decision about the suitability of cloud computing for enterprises that already have working and functional ICT systems. The enterprise must decide either to develop and invest in its own resources or to make changes based on consideration of the total costs or the environmental situation.

The aim of this paper is to define the cost efficiency calculation and analysis method for business processes

transformation to cloud computing systems architecture to ensure that the taken transition is cost efficient and what could be used as a tool in decision making.

In the context of this article, the authors define the business process transformation as a gradual process of many stages and methods which allows executing the process in different environment. For example, if a business process runs in environment A, based on architecture X, these methods may be applied in certain order to allow the resulting process run in environment B, based on architecture Y. The transformation can be used to adapt desktop application to cloud infrastructure. By measuring how effectively alternative solutions can be used to solve a particular business issue and how an enterprise acquires most business and economic benefits for the lowest financial investment, cost efficiency ensures the economic justification of business process transformation.

This is achieved by using a multi-method approach - systematic literature review, analysis of cloud computing costs, comparison between calculation methods, expert interviews and case study of Riga City Council has been used for the evaluation of cost efficiency method.

The paper is organized as follows. Section II describes and identifies the costs of cloud computing solution. Section III provides comparison of cost calculation methods and components for calculating the cost efficiency. Section IV provides the business case to assess if business processes transformation to cloud computing systems architecture was economically beneficial and cost efficient for Riga City Council. The acknowledgement and conclusions close the article.

II. IDENTIFICATION OF COSTS

A. Tangible Costs

Any enterprise planning to adopt cloud computing solution initially has to define the costs of transformation to cloud computing architecture that are attributable to the specific case. They should be defined so one could perform appropriate calculations and evaluations.

Many different ICT costs can be accounted: infrastructure and architecture exploration, evaluation of conformity, transformation costs, infrastructure changes and restoration costs, maintenance costs, hardware costs, software costs, human resources costs, personnel training costs, and other, although it is not possible nor needed to use all these costs in calculation. Costs should be measurable and comparable.

To identify the costs associated with cloud application efficiency and costs calculation cloud application phases and road map of cloud objectives and benefits should be defined. Violin [2] defines that cloud application life cycle consists of four key elements: (1) application strategy, (2) choice of supplier, (3) contracting and (4) management and governance. The Walterbusch et al. [15] defines similar life cycles: (1) initiation, (2) evaluation, (3) transition, (4) activity, and also adds a fifth element -final phase-(5) continuous monitoring of costs to be able to monitor the costs and risks, and move withdraws from the cloud services. Hexware Technologies [9] also defines four-step process if an organization wants to achieve cloud goals: (1) defining cloud strategy, (2) application, (3) ICT optimization or application migration, and (4) business innovation or creation of new business models. Willcocks et al. [13] indicates that the achievement of innovation with cloud resources is a two-stage process, which initially includes: (1) an enterprise cloud computing application, and then (2) innovating using those cloud resources. Enterprises will keep looking for ways to benefit from adoption of cloud computing although the benefit of innovations enabled by cloud computing may be larger [13].

This paper shows how to create cost efficiency model on the basis of cloud application life cycle and costs and benefits during this period, as well as add business innovations phase that will provide overview of benefits and costs in long-term. It defines the road map of cloud costs, objectives and benefits (Figure 1).

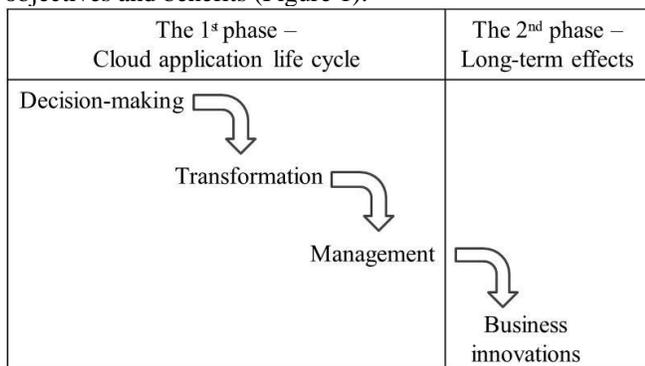


Figure 1. Road map of cloud costs, objectives and benefits.

1) *Decision-making*: This stage includes cost components such as time, consulting services and information for decision-making. This is a very important stage in all of the cloud application life cycle since it entails the analysis of business needs and assessment on whether the possible cloud solution is suitable for the enterprise, its local infrastructure and technologies. It includes analysis of potential costs and benefits, as well as should include calculations. These are initial costs.

2) *Transformation*: This is adaptation stage that includes infrastructure changes. It can be called implementation, configuration, integration and migration and covers costs of transmission and process factors. These also are initial costs. This stage also includes initial training

that can be calculated by time for preparation of internal personnel and external consulting services, and other costs.

3) *Management*: This stage includes ongoing maintenance, operation of cloud services, ICT support and ongoing personnel training. These are running costs.

In order to reflect the full life cycle, the final *closing* stage also should be included, as it includes switch back from the cloud of suitable infrastructure. In this paper authors did not include this stage.

4) *Business innovations*: These have to be evaluated in long-term. It also refers to the impact on the environment and socio-economic indicators and provides a range of evaluation factors that affect use of citizen’s e-services [1]. This phase includes intangible costs and benefits.

B. Intangible Costs

Besides the obvious costs of hardware, software and human resources, cloud solutions entail many other components. Costs that are not visible are always hard to measure. Nonetheless, they are one of the key factors in any analysis since they are just as important as other costs. Enterprises must understand these changes and chose reasonable cloud application strategies and contracts that can reduce risk by estimation of the Service Level Agreement (SLA). The following criteria are not imperative but they can generate extra costs that may, however, be avoided.

If any of the activities are restricted or hindered, long-term cloud benefits will be affected. Therefore, the understanding of the limitations on the cloud computing application is important, just like the factors preventing innovations when using cloud computing [13]. Risks like hidden costs must be considered since they can hurt the expected benefits [16]. It is highly recommendable to reduce the risks for enterprises intending to adopt cloud computing services with a meticulous cost analysis. It is also important to inform enterprises about the factors and various types of costs [15]. Ignoring these figures when making a decision, the enterprises may get to an outcome quite the opposite of the expected economic benefits [2].

1) *Software adaptability*: Interoperability and extensibility are very significant when transforming any new solution. Before any transformation it is important to find the answers to the following questions: how easy will the integration of the software be with other applications or is it going to be easy to adjust the application to enterprise’s needs. Without answers to these questions, the transformation to new solution will require much more time and money [10]. Each time enterprise modifies its software, it should remember that the initial relatively low expenses may lead to high costs of backfitting or maintenance. Improvement of an existing system or installation of the onsite system at the enterprise will more likely have to be replaced in five years. Replacement costs and the amount of the initial hardware investment will be alike, so it is better that these costs are planned. Additionally, after the five-year period customers may want to upgrade the software to the latest edition. The corporate acquisition of software in all areas may reveal the system upgrade costs. It may be

important to make sure the adjustments remain unaffected if the system of the enterprise has been customized. In some cases, when users are added before the update, it might be necessary to purchase additional licenses. On the contrary, cloud improvements tend to be iterative, limiting the improvement in the costs of operation, which is the major reason why the total costs in terms of cloud and local systems differ around the five-year range [3]. Can the cloud application be adapted to the growth of local application development, is another point to consider [10]. There are some enterprises that want to install numerous cloud applications and integrate them to offer additional opportunities for their customers, but they might find that, for example, the integration between the two applications in the cloud is in no way possible [2].

2) *Data handling and storage*: Data handling and storage is one of the indicators with a couple of hidden costs. Data movement often raises costs; the price can be as high as €1 000.00. Cloud providers may require a fee for each download and long-term data storage in the cloud is expensive. Besides, an internally done backup copy of the data storage cloud is more expensive [2]. It might be necessary to buy new server hardware, and these costs may rise over time.

After purchasing the cloud solution, one should plan for the same amount of server hardware investments. However, some may want to purchase a reserve server to support business data from the service provider [3]. Security and privacy policies are especially significant factors to any enterprise, that is why the following question should be answered - what kind of security and privacy policies are applicable to the cloud vendor, and how does it relate to internal policies [10][16]?

3) *Performance and quality*: Performance and quality are certainly the benefits expected to improve with the cloud solution, although this benefit may bring up some hidden costs. SLA could be used to measure quality factors like reliability and availability. The type of guarantees and the risks of changing the technology matter if enterprises go for a cloud solution. Moreover, it is necessary to examine the data center and operations' quality in each technology solution, as well as personnel involvement [10].

The necessity to test the software before transformation to the cloud technology may also bring up hidden costs. Although using cloud configuration can be really cost-efficient and save few hundred thousand euros, it may be necessary to stabilize the system [2]. With a cloud solution, the seller assumes the duty to provide software deployment and maintenance, also ensuring data security. The seller also determines how the enterprise limits its internal ICT costs, although it is not entirely avoidable because there will still be the need to manage the system configuration and local testing to ensure that application is running in the appropriate local ICT environment. ICT has an unpredictable nature and its issues makes it difficult to accurately identify and predict the amount of investment to ensure smooth work of the system, and the ways to manage

ICT locally, which can significantly increase the total cost of ownership of the enterprise [3].

Naturally, there are many costs related with the maintenance of the system of internal resources, but not all of them are covered from the ICT budget. With the arrival of the cloud, the basic infrastructure costs are included in the overall costs. In result, the enterprise has to pay for something (for example, electricity and rent) it was not charged before. Overall, cloud computing application provides lower costs, but requires overall budget changes [2].

Every mathematical approach should apply restrictions that should be considered in the framework of the practical application thereby distancing from the cost types that are not applicable to the given situation [10]. Cost components of each individual situation will vary. Therefore, every case should be evaluated specifically.

III. METHODS FOR CALCULATING THE COST EFFICIENCY

Many studies illustrate and provide information on how the enterprises can benefit from cloud services, but only few enterprises have taken note of this beneficial effect before a final decision [15][17]. Despite the fact that most attention is paid to risks and safety issues, there are authors who have already begun to create new cost calculating models and methods. Most studies illustrate the economic benefits of cloud computing solutions for enterprises; however, a question arises - which method would be most appropriate for calculating cost efficiency and how cost efficiency should be measured?

Frequently used cost calculation methods should be assessed:

A. Return on Investment

Return on Investment (ROI) is one of commonly used calculation method what estimates financial outcome of business investment and provides an assessment of how valuable will be a contribution [11][20]. It includes both the cost of investment (initial, running and closing costs) and the expected benefit from investment (tangible and intangible gains).

Simple calculation formula for ROI is the following:

$$ROI = \frac{(\text{expected benefit from investment} - \text{cost of investment})}{\text{cost of investment}}. \quad (1)$$

The result is expressed as a percentage or proportion. If ratio is greater than 0, it is expected that benefits are greater than costs, so that the investment can be regarded as beneficial [11]. Investment with the highest ROI is regarded as better business decision [14]. Obtaining a meaningful result depends on all the variables for calculating and defining a clear and consistent period of time [19]. For clear estimates, it is important to define clear and measurable benefits and easily known costs. It can be found that ROI calculation can be difficult and misleading for more specific investments, such as cloud computing systems and services [14][20]. Also, the usage of ROI calculation as the only

financial measurement of decision making would not help to predict the feasibility of profit or the risks involved with a particular investment [11]. It is, therefore, necessary to look at other economic benefit calculations.

B. Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) is widely used calculation method what obtains the difference between costs and benefits to decide whether to make changes [14].

To compare the benefits and costs of cloud computing, a number of variations of CBA can be used – Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR). For example, NPV compares the expected benefits and costs of a predetermined time period through rate, which assists in calculating the present value of the future cash flows of transactions [8][11].

The formula to calculate simple NPV of the project is:

$$NPV = \sum_{t=1}^T (benefit_t - cost_t) / (1 + r)^t \quad (2)$$

Costs can be initial and regular, while benefits are mostly received over the time. The time effect is included in the analysis, in the calculation of payback period. This is the time it takes to change benefits for reimbursement of expenditure [14]. Benefits and costs are the future value at specified time *t* (number of periods from the beginning of the project); *r* is the discount rate, and *t* is the year. Also CBA evaluates each project and are defined as successful, if the calculated value is greater than 0 [11].

Simplified cloud CBA would evaluate the economic benefits of cloud computing usage [14], but despite it allows comparisons to be made between investments, it may not be able to include all criteria which are deemed important in evaluation [8]. It is, therefore, necessary to look at another calculation.

C. Total Costs of Ownership

Total Costs of Ownership (TCO) is one of the most recognized calculation methods in assessing potential opportunities for business applications. It helps consumers and enterprise managers determine all the costs (direct and indirect; initial, running and closure) related to a product, service or system throughout its lifetime [14][20]. Basically, TCO is sum of all costs accounted during the life cycle of the solution [15].

The overall TCO can be calculated as:

$$TCO_T = \sum cost_{c,i}^t = a_{f,i}^t * b_f^t \quad (3)$$

TCO calculation includes several cost categories *t* and components *c* in time period *i*. All costs are calculated using variables for consumed or necessary quantity *a_{f,i}^t* in period *i* with unit costs and prices *b_f^t*. It comprehensively considers the entire lifetime spending, capital costs, cost of operations and hence is suitable for base cost estimation [12][20].

It can be concluded that all calculation methods use the information of costs and are valuable tools for decision

making. But, it is not possible to identify one for all needs of businesses.

Advantages and disadvantages of each calculation method should be identified (Table 1).

TABLE I. COMPARISON OF COST CALCULATION METHODS

	Advantages	Disadvantages
ROI	<ul style="list-style-type: none"> - Information about expected savings [6]. - Great for clear and measurable expected benefits and easily known cost of investment [14][20]. - Evaluates the benefits and costs of proposed alternatives [11]. - Calculates costs: return and investment costs (initial costs, running costs, closing costs), time, expected benefits [11][14][20]. 	<ul style="list-style-type: none"> - Difficult to use and misleading for more specific investments such as cloud [19]. - Looks at business benefits, which often cannot be measured as objectively as costs [18]. - Only one ROI calculation would not help to predict the feasibility of profit or the risks involved with a particular investment [11]. - Not very detailed, and thus may not be very accurate [14].
CBA	<ul style="list-style-type: none"> - Information about earnings, expected benefits and costs of cloud computing usage of a predetermined time period through rate, which assists in calculating the present value of the future cash flows of transactions [11][14]. - Evaluates the difference between benefits and costs [6][12]. - Calculates costs: initial and regular costs, benefits over the time, payback period (number of periods from the beginning of the project) [11][14]. 	<ul style="list-style-type: none"> - Not very detailed, and thus may not be very accurate [8][14]. - Does not include process changes and personnel costs or, for example, the benefits of mobility systems [14]. - Future benefits and costs are not measured [8]. - The chosen rate can radically change the results of analysis [8].
TCO	<ul style="list-style-type: none"> - Very detailed and allows the assessment of all the costs throughout the lifetime of the system, service, process or product [12][14][15][20]. - Good to compare two or more alternatives [14]. - Provides a realistic and holistic measure of the long-term costs required to acquire and operate technology solutions [18]. - Identifies hidden costs [4]. 	<ul style="list-style-type: none"> - Only one alternative TCO solution would not prove whether transformation to cloud is efficient, or not [10]. - Is not complete cost benefit analysis [4].

Disadvantage to point out of all previously compared calculation methods is that intangible costs are difficult to value. More sophisticated assessment approaches try to add financial value of the intangible costs. The same is about intangible benefits. For calculating costs of cloud computing solutions it is especially a challenge.

ROI and CBA evaluate investments, but both look at business benefits what cannot be measured as accurately and objectively as costs. It can be seen that CBA and ROI make use of information about earnings and benefits and show how the solution is effective or ineffective. However,

at the same time, the two estimates are not very detailed, and thus may not be very accurate.

TCO can be used as most appropriate calculation method to compare two or more alternatives. It is very detailed, and allows the assessment of all the costs, including identification of hidden costs. But only one alternative TCO solution would not prove whether transformation to cloud is efficient and economically beneficial or not.

Ideally, the enterprise will use several methods of financial indicators in decision, whether to transform the existing business process to cloud computing systems architecture, or improve the local architecture. For cost efficiency calculation most appropriate would be TCO, but it should be improved.

The cloud cost efficiency model can be formed on the basis of cloud activity indicators – Key performance indicators [20], which are assessed as costs in each category:

- **Time:** It includes the time required for the implementation of the solution, as well as the availability period of the service.
- **Costs:** Costs are based on one or more of the method’s results described previously. This paper suggests that TCO is most appropriate as a base for comparing two or more alternatives and it allows calculating costs throughout the life cycle of solution.
- **Margin:** Profitability is the difference between cloud computing solutions and local infrastructure solutions.
- **Quality:** It includes performance and intangible costs.

Cost efficiency method should be at hand to compare two alternatives (two alternative solutions - transformation to cloud solution and improvements of local architecture) for solution of one problem or business needs to calculate which alternative is economically beneficial and cost efficient.

Rigorous cost efficiency calculation and analysis sequence of actions have been defined in Table 2.

TABLE II. COST EFFICIENCY ANALYSIS

A. Business needs	Define the business needs and define potential cloud service model.
B. Evaluation	Evaluate alternatives: (1) define the possible required time for solution implementation, (2) identify the possible costs of cloud computing solution and local infrastructure development, and evaluate them, (3) calculate the cost-efficiency and conduct an assessment, (4) define the potential quality indicators, including the identification of intangible costs.
1) Time 2) Costs a) Decision-making b) Transformation c) Management d) Business innovations 3) Margin 4) Quality	
C. Final decision	Make the final decision.

The alternative is cost efficient if its realization during its life cycle requires the lowest investment. Cost efficiency analysis should include definition of business needs, evaluation and comparison of alternative solutions and final decision. Evaluation should include calculation and analysis of tangible and intangible costs.

IV. COST EFFICIENCY BUSINESS CASE

A. Business needs

Common ICT solutions development and support for employees to provide fast and effective high quality services to clients is the main goal of Riga City Council concerning the ICT. Centralization in local authorities including Education, Culture and Sports Department subordinate institutions – schools was one of the biggest challenges for Riga City Council in the year 2011/2012.

Municipality had to find a new ICT solution that could be appropriate for financial statements delivery to employees, ensuring the confidentiality of documents and electronic accessibility. There are more than 10 thousand school employees and pupils in schools of Riga City.

It was necessary to decide whether to invest in its local infrastructure or transform to cloud solution. Potential benefits of cloud solution allowed make the decision, but whether it was cost efficient?

In this case, it is not possible to perform the measurement of economic performance with existing solutions, because there was no solution at all. E-mail implementation was a new challenge for decision makers. Without a new e-mail solution, it would not be possible to provide the current technological opportunities.

B. Evaluation

1) *Time:* Transformation to the cloud as a whole took three months. Ad hoc solution would need at least six months. Usually enterprises for adopting cloud solution would need less time. When outsourcing data to the cloud, users and enterprises essentially lose control over their data, but Municipality has strong regulations and requirements on data handling and storage. Also acceptance of other decisions needed more time.

Service accessibility time would be identical for both decisions.

2) Costs

a) *Decision-making:* Decision making costs include all involved specialist’s time, what is necessary for strategic decision, expenses of information upon which to base the decision and expenses of consultations.

In example of Riga City Council, strategic decision took 16 work hours. Hourly rate of the decision-maker and the ICT personnel was 50€/h. Information materials were not used. The evaluation was conducted by an external consultant pricing at 70€/h and it took 40 hours. Decision making would require an identical time for both – improvements of local system and transformation to cloud computing system’s architecture.

b) *Transformation:* Transformation costs of cloud computing approach demanded €50 000.00. Implementation, including the training, was carried out in 5 days. Standardized transformation to cloud solution took less time than it would take if Municipality would improve its local architecture. The calculations do not include purchase of new hardware because it was not necessary.

c) *Management*: In evaluation of the management phase of business processes that is dependent on the service provider's offer, the service availability is very important, and needs to be available 99.99% of time. These values can be provided only by a cloud service provider.

In addition, cloud technology application reduces the capital and operation costs associated with servers, system licenses, system maintenance, data center and necessary support personnel. Maintenance is very important for service availability. Cloud computing approach requires only one day a year, which is 8 hours x €70 hourly rate of the service provider. For traditional enterprise software it would be €50 000.00, which includes servers and disk space, licensing and maintenance as well as additional required human resources.

Access to e-mail is provided to 17 000 employees and 30 000 pupils. Access price is set as part of annual maintenance.

Closing costs were not included in the calculation. In both cases, it would be €56 000.00.

TABLE III. COMPARISON OF COSTS

	Transformation to Cloud Solution	Improvements of Local Architecture
Decision making	3 600.00	3 600.00
Transformation	52 000.00	56 000.00
Management	47 560.00	97 000.00
Total:	103 160.00	156 600.00

Table III reflects that costs of transformation to cloud computing architecture are lower - €103 160.00 compared to €156 000.00 if Municipality would decide to invest in developing its local architecture. It can be concluded that the transformation to the cloud solution has been cost beneficial.

Figure 2 confirms that costs of transformation to chosen cloud solution was less than if improvements of local architecture would be implemented.

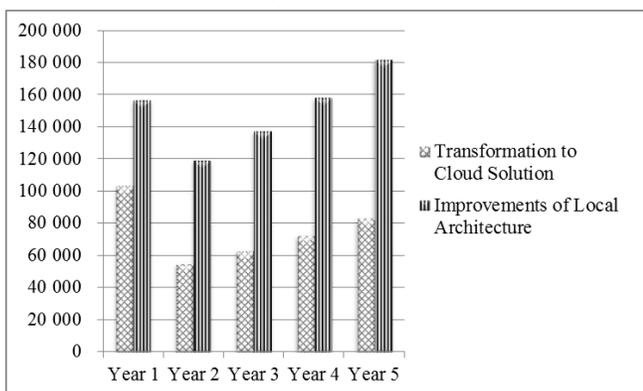


Figure 2. Comparison of costs (five year perspective).

Costs have to be assessed in at least five years perspective, to make sure that cost of two alternative solutions differences also in further years, since the first year involves investments in a new technological solution. The first year also involves the costs of decision making and transformation. Starting from the second year, these costs

are not included. Growth of costs is assessed with a 15% inflation increase. Inflation rate shows the difference margin more effectively.

d) *Business innovations*

Business development: Faster response ability can improve service delivery, satisfaction and corporate relations of citizens, businesses, employees and suppliers. Redistribution of ICT operational activities offers enterprises the opportunity to focus on business development, including new and innovative applications that enable business and product development to provide better services. Cloud solution often causes creation of new solutions that were not technically and/or economically feasible without it [15]. Cloud computing can help to maintain or analyze large amounts of data disclosure and fraud. Thus, it can control corruption and improve e-governance processes - application migration to any resident, lost data recovery, data copy establishment, pollution reduction, and other expenses [21]. Cloud computing can also help human resources professionals to cope with various issues to ensure effective talent management, since it can help to solve the main problems of affordability, accessibility, timeliness, ease of use as well as integration. It also offers a technological solution with a potential of organic change that would happen in accordance with the enterprise's own changing needs. Personnel have important role as from it depend decision whether transformation to cloud computing solution will be chosed and integration has been done correctly.

Impact on the environment: As one of the quality indicators can be counted green and sustainability costs. Impact on the environment means savings from paper, energy and electricity.

The e-mail cloud solution also used service that delivers documents electronically. As a result, there was no need for the printing of large amount of papers and transportation anymore. That is, since there are 17 000 employees receiving payment documentation every month, and, if the cost of one printout is €0.10, causing the costs of electricity, depreciation of equipment and tear, as well as petrol consumed in the process of delivering the payment documentation, it can be concluded that for Riga City Council it costs €1 700.00 monthly. That makes €20 400.00 per year. In five-year's perspective, savings are €102 000.00 already. This is the whole amount if costs do not increase each subsequent year.

This solution is an important factor in impact reduction of technologies to the environment (air conditioning, electricity, and other), that allows to achieve significant long-term goals.

Impact on society: This cloud solution provides a number of key benefits, which affect not only the e-governance areas but has an impact on society too.

Every pupil and teacher is provided with a single e-mail address that can be used for professional purposes and provides a corporate image. Pupils may use this tool for sending documents, mutual communication projects, as well as for sharing documents. It saves their time and resources. On the other hand, by using this e-mail, teachers can send

transcripts to pupils – that is comfortable and safe. The Microsoft e-mail can be used as a tool for a variety of projects; it is possible to create groups and chat. It provides a quick and convenient use. It also ensures the reliability of the Municipality and sent documents.

3) *Margin:* As shown in Table IV, in five-year perspective, estimating an inflation of 15%, cost difference between cloud solution and improvements of local architecture will be formed as €377 236.90 savings.

TABLE IV. COST MARGIN

Year	Transformation to Cloud Solution	Improvements of Local Architecture	Margin
1 st	103 160.00	156 600.00	534 40.00
2 nd	54 694.00	119 539.30	648 45.30
3 rd	62 898.10	137 470.20	745 72.10
4 th	72 332.82	158 090.72	857 57.91
5 th	83 182.74	181 804.33	986 21.60
Total:	376 267.65	753 504.55	377 236.90

It should be noted that in five-year perspective, the ad hoc solution would need to include system upgrade costs.

4) *Quality*

a) *Software adaptability:* This solution has brought several intangible costs. The first was adaptability as it was necessary to integrate the application with Riga City Council’s local cloud solution and local systems. The first challenge was to create a mechanism that would find out how teachers and pupils are going to receive e-mail addresses and access them, and an identity maintenance was created for employees and pupils. This would also be necessary if the local infrastructure was developed.

b) *Data handling and storage:* Microsoft changed the technological infrastructure standard from Live@EDU to Office365 one year later, so it was necessary to remake authentication solution as well as develop local systems. To ensure that the existing Office365 authentication temporary solution replacement and school infrastructure business continuity, authentication solution development demanded €54 000.00, but system development – €18 000.00. Unfortunately, a vendor may keep the rights to change its solution.

c) *Performance and quality:* Quality also includes calls to errors or losses. Larger losses would be caused in the case of ad hoc improvements. It would go up to €200 000.00 while the cloud solution is €50 000.00 which is €150 000.00 less.

C. *Final decision*

Technology develops fast, and society develops along with it. At present, it is inconceivable that employees and pupils of Riga City Council would not have a uniform e-mail system. Although they do not have to worry about the costs of the solution, indirectly this solution also reduces their costs – in terms of time and finance. Nowadays cloud computing is the ICT sector’s innovation around the world that provides immediate benefits but more importantly - the substantial long-term benefits. This solution is flexible because it is available on mobile devices, directly contributing to the development of the information society.

Riga Municipality ICT architecture strategic direction is to move to a new ICT governance model for the implementation of a significant innovation, thus providing substantial economic and social benefits for its customers (citizens and employees).

We conclude that business process transformation to cloud computing systems architecture was cost efficient, and provided analysis method for business processes transformation to cloud computing systems architecture can be useful as a tool in decision making.

V. CONCLUSIONS

While cloud computing can provide clear benefits of total costs to any enterprise, which can be calculated by taking into account the TCO calculation method, it is crucial to take into account also the individual business requirements and hence the applicable components for each case individually. This can all be fixed in the decision-making phase.

It is necessary to understand that some enterprises may require specific features or functionality that is not available as a cloud solution. It is necessary to assess whether the enterprise wishes to customize the solution to the basic level, something that is only possible in the local, on-site software model. There is a need to assess business requirements and then evaluate each vendor’s ability to meet this requirement. In the given example, the business cloud solution was available, and by calculation, as well as through business assessment, it can be concluded that the decision has been economically beneficial and efficient.

Enterprises planning to use the cloud computing services are advised to thoroughly analyze costs to minimize risks and learn about all the cost types and factors.

In order to select the most appropriate solution and decide whether to improve the existing architecture or to implement the cloud computing solutions, it is recommended to invest more in the decision-making stage (evaluation) - a process that enterprises often neglect and as a result it can lead to inadequate achievements. This is particularly important because every cloud solution varies depending on the components; it is suggested that the costs and benefits must be carefully considered over at least a five-year perspective, including intangible costs and benefits. Generally, enterprises can see that costs pay off in the second year already, as it is well presented in the given example. As technology develops approximately every five years, it is necessary to take into account that use of the ad hoc solution will require to invest in infrastructure and technological improvements. Those costs can be as much as the initial costs of the solution. That is why it would be useful to be aware of costs in more than a five-year perspective. However, if the enterprise has chosen the cloud solution, and especially outsourcing, it does not have to think about it.

During the cost efficiency evaluation to determine whether the cloud computing is an economically beneficial and effective solution, other important factors also has to be assessed that are related to cloud innovation stage, which is associated with long-term and socio-economic factors.

After all, the purchase and implementation of the software is a business, not a technology decision. The type of technology that is chosen according to the business requirements of enterprises and organizations is different compared to the corporate business objectives, needs and risks the company is willing to admit. It is crucial to understand that each delivery model has advantages and disadvantages, both the financial and technological restrictions must be taken into account, as well as the specifics of the business.

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