ERP in clouds or still below

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Abstract

Purpose – The purpose of this paper is to investigate the market readiness to adopt the Cloud as the future ERP platform, by using the analytic hierarchy process (AHP) decision support methodology.

Design/methodology/approach – Interviewing is conducted on the convenient sample, of enterprises from various industries. The interview is conducted through expert telephone interview and self-administered questionnaire. Results are then used as a basis for forming the weight factors necessary for the AHP decision model. Data are analyzed and synthesized using AHP and Expert Choice.

Findings – Results demonstrate a huge interest for TCO reduction, but also a concern for data privacy and availability. Large enterprises want their data on local servers, while smaller companies tend to act as “first adopters”, mainly because of the cost benefits that Cloud offers. Finally, vendors see the hybrid solutions as the most suitable approach for the overall market, at least while current Cloud obstacles exist.

Research limitations/implications – This research does not aim to answer the question what is the best solution for a particular industry. Instead, it assumes the general approach, which answers the question what would in general be the adequate solution for the SME and how much are SMEs ready to adopt the ERP in the Cloud. A further research is necessary to validate these results in practice. That research should be industry specific, i.e. narrowed to one industry only. Then, it would be possible to answer the question what is the best solution for high-tech SMEs.

Practical implications – This paper summarizes Cloud pros and cons useful for decision makers to establish a starting point for IT reorganization. Additionally, AHP results provide some indications of the market’s perception regarding Cloud and ERP, while vendors’ statements about ERP-Cloud solutions provide an interesting glimpse of the ERP market in the next few years.

Originality/value – Market demands constant flexibility and cost effectiveness, forcing companies to adapt faster than ever. Therefore, there is a significant risk for first adopters and their business if they adopt an inadequate solution. This paper offers a high-level overview of the SME’s market understanding and willingness to adopt ERP in the Cloud idea, and it demonstrates how the AHP decision support methodology can be used to assess the readiness of enterprises to adopt the Cloud-ERP solution.

Keywords Cloud computing, Decision support systems, AHP, ERP

Paper type Research paper

1. Introduction

The Global Economic Crisis (2007-present) has earned to be written in capital letters, not only because of its global impact, job loss and closed companies, but because it has and still is redefining the way business investments are made. Many ventures have been cutoff, projects have been put to a halt and plans have been re-evaluated. However, no matter how hard the crisis is, some cost elements are necessary even in the harshest times.

Regardless of the company size and its core business, there is always a need to consolidate business documents and processes.

Enterprise resource planning (ERP) systems have been developed to accommodate these needs and to help organizations stay competitive. As such, ERP is considered being the price of entry for running a business (Shehab et al., 2004).
Although the licensing costs of the ERP can be relatively high, the price of implementation and maintenance fees are the most common problems when it comes to financial aspects (Klos and Krebs, 2008). Companies like Baan, PeopleSoft (owned by Oracle) and SAP, have calculated that the implementation price together with some operational and so-called hidden costs can be from three to seven times the licensing price.

Small and medium enterprises (SME), which were previously unable to buy expensive, large systems, are now seeking a solution that can accommodate their business needs. Knowing the price of licensing, implementation and maintenance as the main limitation, it is almost impossible for SME’s to acquire one of the de facto ERP systems.

On the other hand, a need for thorough re-examination of ERP investment and strategy has emerged as perhaps the only positive outcome in IT, after 18 month long economic and business chaos during financial crisis (Wailgum, 2009).

The need for reinvention of the wheel through current and future IT strategies has brought back the old long-held dream of computing as a utility, which is revamped as Cloud computing.

The budget cut-offs definitely gave the momentum to the Cloud idea, as the alternative to monolith, in-house hosted, expensive systems.

According to Berkley view of Cloud computing (Armbrust et al., 2009) the elasticity of resources provided by Cloud architecture, without paying for large-scale computers is unprecedented in IT history. Cloud allows companies to use virtually infinite number of servers, without actually owning them, which makes it the next generation of network computing (Sun Microsystems, 2009). As such, Cloud architecture is perceived as the mean of addressing IT’s tactical problems, like costs, process standardization, resource availability and reliability (Winans and Brown, 2009).

Taking into account that modern economy demands flexibility and almost instant adaptability to market fluctuations, it is to be expected that SME’s are becoming the main driving force, encouraging IT industry to bring new concepts and daring innovations.

The purpose of this paper is to present the possibility of modern ERP being integrated within the Cloud in order to suit the needs of fast growing and dynamic SME market. The main assumption, on which this paper is based, is the necessity for increased cost efficiency in IT and that the Cloud environment is relatively the right answer. In addition, the Cloud paradigm in this research is regarded as the general concept, without diversification between different Cloud types (public, private, community, etc.). Second, because of the assumption of relativity, it is necessary to choose an appropriate perspective from which to conduct the discussion in this article. For this a managerial perspective is chosen, because it offers the most relevant perspective having in mind the target audience, i.e. decision makers.

2. ERP: concept, history and overview

The ERP concept alone comprises a set of applications that function collectively in a single information system, over a single database (although it can be connected to multiple databases), assisting all the cardinal areas of business, including but not limited to management, sales, human resources, customer relations, finance and accounting, etc. (Plant and Wollcocks, 2007; Shehab et al., 2004).

From a technical point of view, an ERP provides almost real-time processing (Siriginidi, 2000), centralized data repository, platform and database independency and
client server architecture (Al-Mashari et al., 2006). In addition, a modern ERP should provide interfaces to external legacy systems (SAP Technical Guide, 2008).

It is supposed that an ERP can act as strategic tool, which helps companies in reaching and keeping competitive advantage, through integration of business processes and optimization of available resources (Yun et al., 2003).

With enormous level of inter- and intra-organizational integration (Subramoniam et al., 2009), a successful implementation and adoption of the ERP can lead to drastic declines in inventory (Huang et al., 2009), reductions in working capital, detailed information about customer needs, behaviors and habits, optimized supply chain (Ball et al., 2002; Huang et al., 2009) and ability to provide ad hoc business intelligence reports. According to some reports, the ERP ability to optimize supply chain and inventory can lead to as much as 35 percent reduction in costs (Gupta, 2000).

Despite some ambiguous claims whether ERP is or is not a source of competitive advantage for a company (Peter, 2005) there is no doubt what benefits an ERP can bring. Even Seddon agrees in his paper “Are ERP systems a source of competitive advantage?” (Peter, 2005) that ERPs seems to be an important source of operative effectiveness, while Davenport et al. (2002) reports ten key benefits achieved over time in 163 interviewed organizations that had adopted enterprise systems.

The evolutionary path for ERP systems was (in IT terms) a long one, but after 30 years of improvement, it is still far from over.

According to Klos and Krebs (2008) it has been noted that the number of scientific publications dealing with ERPs have increased significantly and having in mind that ERP is not just a plain software package, but it influences how people work and often imposes its own logic on a company’s strategy, organization and culture, it is clear that the number of research papers dealing with ERP will increase even further.

3. Challenges and possible directions

Relying on extensive industry and client facing experience, reviewed industry and research papers and SAP’s best practices and recommendations (Ball et al., 2002; Dezdar and Sulaiman, 2009; Huang et al., 2004, 2009; Kimberling, 2006; Klos and Krebs, 2008; Mell and Grance, 2009; Plant and Wollcocks, 2007; Saatcioglu, 2009; Subramoniam et al., 2009), this paper summarize existing ERP drawbacks into four categories:

1. cost of ownership and implementation;
2. functional drawbacks;
3. technical drawbacks; and
4. usability.

Table I elaborates each group and its sub items.

The cost of ownership and implementation category is by far the most important one from the CEO/CFO angle. Functional and technical category concern CIOs and implementation staff the most, while end-users are mostly affected by the obstacles from usability category.

Despite big improvements over the last years, the scale of business process re-engineering (BPR), which a company needs to accept in order to use the full potential of adopted ERP, is still one of the main reasons for dissatisfaction with ERPs (Subramoniam et al., 2009).
On top of that, maintenance costs are significant. Large vendors, such as SAP and Oracle have mandatory maintenance models, which according to their sales department can cost up to 22 percent of the license price.

According to Veverka (2009), Oracle’s income from maintenance fees is more than 51 percent of its total revenue and SAP’s is 50.7 percent (SAP Investor Relations, 2013). With all the aforementioned issues, implementation, and associate service costs, not many can afford to go for an ERP implementation.

Having in mind that one of the market driving forces in the new economy are the SMEs, it is clear that one path of future ERP evolution is going to be in the direction of SMEs. The new technology paradigm, the so-called Cloud computing brings a brand new concept of business virtualization when it comes to ERP market and it can be seen as the promising approach for the new breed of ERPs for small and even medium enterprises.

It allows companies to outsource almost complete IT infrastructure and to pay for it on-demand.

4. Definition of Cloud and some concerns
From the very beginning of the internet, there was a dream of computing as a utility, where everything is available at any time and placed inside the “internet Cloud”. There are some global projects which tend to fall under the definition of Cloud computing, like peer-to-peer networks such as various torrents or volunteer computing like SETI@home, but until recently, there was no enterprise application like ERP available from within the Cloud.

Chances are that this status quo would remain for a while if there was not for global economic crisis (Wailgum, 2009).

<table>
<thead>
<tr>
<th>Cost of ownership and implementation</th>
<th>Functional</th>
<th>Technical</th>
<th>Usability</th>
</tr>
</thead>
<tbody>
<tr>
<td>License cost</td>
<td>Absence of multi-accounting principles support (e.g. IFRS, US-GAAP)</td>
<td>Integration between ERP and legacy systems</td>
<td>Complex and not standardized user interfaces</td>
</tr>
<tr>
<td>Long implementation cycles</td>
<td>Limited reporting capabilities and no ad hoc reporting</td>
<td>Cross-solution integration between different components</td>
<td>Obscure terminology often changed by marketing department</td>
</tr>
<tr>
<td>Optimized and tailored mainly for large enterprises</td>
<td>Missing decision support functionality</td>
<td>Limited capabilities in data migration and data upload functionality</td>
<td>Often complicated editing operations (select all, cut-copy-paste)</td>
</tr>
<tr>
<td>Cost of implementation</td>
<td>Deficiencies in plant management, material management and financial accounting capabilities</td>
<td>Deficiencies in existing data interfaces</td>
<td>Lack of detailed help files</td>
</tr>
<tr>
<td></td>
<td>Lack of comprehensive customizing set in “out of the box” solution</td>
<td>System and landscape-wide monitoring and scheduling</td>
<td>Different terminology used by various vendors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Single point of failure and high availability</td>
<td></td>
</tr>
</tbody>
</table>

Table I. Drawbacks and obstacles of ERP systems
Being a relatively new term there is still a certain amount of vagueness concerning the definition of Cloud computing. Furthermore, there is often confusion between Cloud computing, software as a service (SaaS), grid computing, utility computing and autonomic computing.

Indeed, a difference is sometimes difficult to see, especially because these terms overlap each other.

It was not before long that the National Institute of Standards and Technology (NIST) gave its voice, by publishing the NIST definition of Cloud computing.

According to NIST (Mell and Grance, 2009) Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Cloud services can be delivered through three different service models: Cloud SaaS, Cloud platform as a service (PaaS) and Cloud infrastructure as a service (IaaS). In addition, there are four possibilities of Cloud deployment or for deployment models: private Cloud, community Cloud, public Cloud and hybrid Cloud (Mell and Grance, 2009).

Having in mind the aforementioned, this paper will define the Cloud as a collection or set of applications delivered as services over the internet and the hardware and system software in datacenters that provide those services.

In parallel, with the confusion about multiple definitions, arguments have been made for and against the Cloud concept. In Berkley’s view of Cloud computing, Armbrust et al. (2009) gave a quick overview of ten obstacles and opportunities of the Cloud concept (Table II).

The IBM sponsored article by Stratecast Frost & Sullivan (2012) also brings some recommendations regarding adequate strategy for Cloud implementation.

When it comes to business critical functions it is still a general preference to keep them between four walls, but on the other side, some simpler functions like automation

<table>
<thead>
<tr>
<th>No.</th>
<th>Obstacle</th>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Availability of service</td>
<td>Use multiple Cloud providers; use elasticity to prevent DDOS</td>
</tr>
<tr>
<td>2</td>
<td>Data lock-in</td>
<td>Standardize APIs; compatible SW to enable surge computing</td>
</tr>
<tr>
<td>3</td>
<td>Data confidentiality and audit ability</td>
<td>Deploy encryption, VLANs, firewalls; geographical data storage</td>
</tr>
<tr>
<td>4</td>
<td>Data transfer bottlenecks</td>
<td>FedExing disks; data backup/archival; higher BW switches</td>
</tr>
<tr>
<td>5</td>
<td>Performance unpredictability</td>
<td>Improved VM support; flash memory; gang schedule VMs</td>
</tr>
<tr>
<td>6</td>
<td>Scalable storage</td>
<td>Invent scalable store</td>
</tr>
<tr>
<td>7</td>
<td>Bugs in large distributed systems</td>
<td>Invent debugger that relies on distributed VMs</td>
</tr>
<tr>
<td>8</td>
<td>Scaling quickly</td>
<td>Invent auto-scaler that relies on ML; snapshots for conservation</td>
</tr>
<tr>
<td>9</td>
<td>Reputation fate sharing</td>
<td>Offer reputation-guarding services like those for email</td>
</tr>
<tr>
<td>10</td>
<td>Software licensing</td>
<td>Pay-for-use licenses; bulk use sales</td>
</tr>
</tbody>
</table>

Source: Armbrust et al. (2009)
of talent management, HR, etc. are moved to Cloud in order to reduce the license and maintenance fees, especially by utilizing pay-on-demand models.

5. ERP markets and a glimpse of Cloud offerings

Constant market fluctuations on local, regional and global levels coupled with the economic rise of some countries, make ERP market analysis and future predictions very specific and complex. According to ARC Advisory Group’s (2007) estimations, by 2011 the value of the ERP market was $25 billion, which is an annual growth of 6.7 percent.

This is just the license cost, while some early surveys conducted by AMR Research (Shepherd, 2009) were predicting that the total ERP spending will increase.

Similar predictions are stated by Gens (2011) in an IDC article depicting top ten predictions for 2020.

The same research had reported a core ERP license revenue increase of 18 percent (as the “core” ERP AMR is including finance, order management, inventory control, purchasing and manufacturing functionality).

In addition this research also claims that, in the future, SaaS will become the dominant solution not only for SMEs, but for large enterprises as well, although there are some concerns among big company CIOs.

Knorr (2012) states in his viewpoint that 2013 will be the year when number of large enterprises moves their core applications, including ERP, to the Cloud.

Large vendors like SAP and Oracle are trying to compete in the SME market with Microsoft, Infor, Sage Group, Lawson and Epicor, but so far they did not have much success (SAP had to withdraw its SaaS SME solution – Business By Design, because it is still not ready), as they are traditionally oriented towards large enterprises (unlike Microsoft and others).

Despite the fact that some decline from firstly mentioned predictions is notable, mainly because of the market changes and later the 2008 economic crisis, there is no doubt that the ERP market is still growing and it will continue to do so.

Although there are many Cloud vendors in the market, the reality is that most of them are offering either beta products or just the basic infrastructure. In spite of the fact that Oracle and SAP are more interested in large enterprises, they are keen on entering the “Cloud race”. For instance, SAP believes that hybrid models – a fusion of traditional data centre services that can be seamlessly incorporated with Cloud architecture, will be the future (Phadnis, 2009).

6. Methodology

The research is conducted as quantitative business to business (B2B) research, through mixed mode survey (expert telephone interview and self-administered questionnaire, distributed per e-mail – Figure 1).

The survey sample is conducted on a convenient sample, which consists of 106 SMEs. The qualified respondent is a senior professional with minimum of five years experience in IT for non-managers (administrators, solution architects and consultants) and minimum of ten years of experience for managers (project and program managers, technical directors, chief information officers (CIOs) and chief financial officers (CFOs)). Additional requirement was that the SME has a need for ICT restructuring, is interested in Cloud platform and has or is considering ERP. Furthermore, the qualified respondent must have
been or currently is involved in a complex decision making and implementation cycle concerning total cost of ownership and system maintenance, security, and availability.

SMEs included in the interview are covering retail, manufacturing, financial services, healthcare, high tech, transportation and media, all equally present in the convenient sample. All respondents and interviewees are from both, developed economies of Western EU, Japan and the USA, as well as from emerging markets of China, Russia, Balkan and Brazil. Total number of contacted SMEs was 141, and the response rate was 75 percent, which represents 106 SMEs that are interested in Cloud platform and have or are considering to have an ERP.

The total number of individuals covered by the interview and self-administered survey was 457. It was an imperative from each processed SME to obtain results from at least one member of each level of company’s hierarchy; C-level management (CIOs and CFOs), middle management and IT personnel. Among the total number of processed individuals 53 percent were IT personnel (consultants, solution architects, administrators), 24 percent were technical directors, project and program managers and 23 percent were C-level managers (Figure 2).

All results were processed using Expert Choice software, which is based on the analytics hierarchy process (AHP) methodology. Individual results are grouped together and the arithmetic mean is calculated, which is used as a basis for calculating results for every particular SME.

AHP is a decision making methodology, developed by Saaty (1980) for facilitating complex decision processes. It consists of three stages:

Figure 1. Distribution of survey methods

Figure 2. Distribution of a convenient sample
(1) establishment of structural hierarchy;
(2) establishment of comparative judgements and synthesis of priorities; and
(3) measurements of consistency.

The hierarchy is structured of an overall objective, alternatives and criteria. The criteria are facts that determine certain characteristics of given alternatives. In case of ERP and Cloud, these facts represent summarized result of:

- author’s extensive professional client facing experience;
- published industry papers;
- research paper reviews;
- SAP’s best practices and recommendations (as one of industry leaders in ERP and Cloud market, according to Shehab et al. (2004), Yen et al. (2001), Armbrust et al. (2009), Ryan (2011), Stevens (2011), Hewlett-Packard White Paper (2012) and Schubert et al. (2012); and
- summarized results of conducted interviews.

For purpose of the AHP hierarchy, facts are grouped into decision criterions (Table III). These criterions are then compared to each other using a set of comparison matrices of all elements. The comparison is done through a pair wise comparison, in terms of how much is an element $A$ more important than element $B$. These preferences are quantified using a nine-point scale, presented at Table IV.

When completed, the pair wise comparison generates matrices with weights for every criterion, further used for calculating eigenvectors.

The basic principle of AHP methodology assumes we wish to compare a set of elements organized in pairs. Objects intended for comparison are denoted as $A_1, A_2, \ldots, A_n$ and the

<table>
<thead>
<tr>
<th>Decision elements</th>
<th>Favored type of deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cost of ownership</td>
<td>Cloud</td>
</tr>
<tr>
<td>2. Licensing possibilities</td>
<td>Cloud</td>
</tr>
<tr>
<td>3. Maintenance</td>
<td>Cloud</td>
</tr>
<tr>
<td>4. Environment upgrade possibilities</td>
<td>Local</td>
</tr>
<tr>
<td>5. Software environment upgradability</td>
<td>Local</td>
</tr>
<tr>
<td>6. Hardware scalability</td>
<td>Local</td>
</tr>
<tr>
<td>7. Standardization of services</td>
<td>Local</td>
</tr>
<tr>
<td>8. Standardized software interfaces and management tools</td>
<td>Local</td>
</tr>
<tr>
<td>9. Platform and vendor diversification</td>
<td>Local</td>
</tr>
<tr>
<td>10. Service persistence and data resistance</td>
<td>Local</td>
</tr>
<tr>
<td>11. Data confidentiality</td>
<td>Local</td>
</tr>
<tr>
<td>12. Data security and integrity</td>
<td>Local</td>
</tr>
<tr>
<td>13. Sensitivity to hacking</td>
<td>Local</td>
</tr>
<tr>
<td>14. Data and service availability</td>
<td>Cloud</td>
</tr>
<tr>
<td>15. Performance</td>
<td>Local</td>
</tr>
<tr>
<td>16. Data transfer bottlenecks</td>
<td>Local</td>
</tr>
<tr>
<td>17. Ability to provide 24/7 online access worldwide</td>
<td>Cloud</td>
</tr>
<tr>
<td>18. Reduction of “single points of failure”</td>
<td>Local</td>
</tr>
</tbody>
</table>

Table III. Elements that influence decision on Cloud adoption
corresponding weights as \( w_1, w_2, \ldots, w_n \) where \( n \) represents the total number of objects being compared. The pair wise comparison of objects produces the relative weights of compared objects, by creating the square reciprocal matrix \( A = (a_{ij}) \) of order \( n \), where \( a_{ij} = 1/a_{ji} \) for \( i \neq j \) and \( a_{ii} = 1 \), where \( i \) and \( j \) are representing the position of an element in the matrix (Table V).

The weight factors are consistent if they follow the transitivity law, \( aRb \land bRc \Rightarrow aRc \) where \( a, b \) and \( c \) are objects that are compared and \( R \) denotes a relation between elements.

Next step in AHP calculation is to find a vector \( v \) of order \( n \), such that \( Av = \lambda v \). The vector \( v \) is said to be eigenvector and \( \lambda \) is its eigenvalue. For a consistent matrix it applies that \( \lambda = n \).

The AHP pair wise comparison relies on human judgements, so the transitivity law does not always apply, as human judgements are often inconsistent. To calculate the inconsistency index, a vector \( v \) needs to satisfy the equation \( Av = \lambda_{\text{max}} v \) and \( \lambda_{\text{max}} \geq n \). If \( \lambda_{\text{max}} = n \) judgements are consistent, but in case there is a difference, the consistency index is calculated from \( (\lambda_{\text{max}} - n)/(n - 1) \). AHP then assesses this index against completely random judgements. If the consistency index is larger than 0.1 the judgements may be too inconsistent and they need to be readjusted.

The eigenvector represents the relative importance of a particular element, where every out of \( n \) elements has its own eigenvector. The sum of all the eigenvalues is 1. Decision elements used in the interview and survey were the same and were formed based on findings on the importance of various variables determining the IT based decisions, as previously described. The summarized result given in a list of 18 variables (Table III) determines the one common goal of the AHP hierarchy in this research paper; “Define the most suitable ERP deployment between three alternatives” (Figure 3).

<table>
<thead>
<tr>
<th>Importance</th>
<th>Verbal representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally important</td>
</tr>
<tr>
<td>3</td>
<td>Moderately more important</td>
</tr>
<tr>
<td>5</td>
<td>Strongly more important</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly more important</td>
</tr>
<tr>
<td>9</td>
<td>Extremely more important</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate values between two adjacent ranking</td>
</tr>
<tr>
<td>Reciprocals</td>
<td>Reciprocal values are assigned when criterion’s B importance is compared to criterion’s A</td>
</tr>
</tbody>
</table>

Table IV. AHP nine-point ratio scale for pair wise comparison

Source: Saaty (1980)

<table>
<thead>
<tr>
<th></th>
<th>( A_1 )</th>
<th>( A_2 )</th>
<th>( \ldots )</th>
<th>( A_n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_1 )</td>
<td>( w_1/w_1 )</td>
<td>( w_1/w_2 )</td>
<td>( \ldots )</td>
<td>( w_1/w_n )</td>
</tr>
<tr>
<td>( A_2 )</td>
<td>( w_2/w_1 )</td>
<td>( w_2/w_2 )</td>
<td>( \ldots )</td>
<td>( w_2/w_n )</td>
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<tr>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>( A_n )</td>
<td>( w_n/w_1 )</td>
<td>( w_n/w_2 )</td>
<td>( \ldots )</td>
<td>( w_n/w_n )</td>
</tr>
</tbody>
</table>

Table V. Pair wise comparison matrix with relative weights

Source: Saaty (1980)
The questions in the survey and interview are formed as a set of pairs from the same level of hierarchy (Figure 3), where each respondent needed to verbally judge how much one item is more important than the other.

As survey results were in form of verbal judgements, the first step of result processing was to assign them the respective numerical values, according to Saaty’s AHP nine-point ratio scale (Table IV). These values were then entered into Expert Choice AHP software, which then calculated the individual synthesis with respect to the given goal, which made a cluster of 457 synthesis results. These results formed a basis for calculating the arithmetic mean, which represents the final result of the AHP synthesis. The alternatives are compared with so-called distributive approach, i.e. they are compared with each other with respect to their relative dominance.

The next sections of this paper present a decision-making hierarchy, combined with the what-if analysis, based on the scholar, industry and white paper review, and the mixed mode survey with decision makers from various SMEs, finally indicating if and to what extent elaborated SMEs are willing to adopt the ERP in Cloud idea. What-if analysis demonstrates how the arbitrary change of weight factors for an order of magnitude of 20 percent influences the results of the AHP synthesis. If results do not change, the pair-wise comparison and synthesis are correct.

7. Results
In contrast to a full ERP deployment on local servers, there are two alternatives:

1) full deployment in the Cloud; and

2) hybrid deployment, where non-critical components are “Cloud based”, while critical ones are deployed on local servers.
As described at the beginning of the paper, 18 elements have been identified, which influence the decision whether to adopt the Cloud, go for a hybrid approach or stay with the local server deployment (Table III). Subsequently, for every decision element in Table III it is stated what the best deployment model is; the Cloud or local server.

The same applies to the hybrid model in a way that if the critical component must have, e.g. high level of data confidentiality, it is recommended that it is deployed on local servers and if for one component a cost of ownership is imperative, the recommendation is with the Cloud.

Furthermore, a decision-making hierarchy has been constructed with respect to the main goal: define the most suitable ERP deployment while keeping in mind the three deployment alternatives (Figure 3).

The synthesis of comparison results shows an interesting outcome in a way that when it comes to ERP and having in mind cost reduction, data and service availability and data security, as the most influential elements, SMEs are not absolutely ready to migrate to the Cloud (Figure 4 – higher value is more relevant).

While Cloud deployment is cheaper and more preferred with respect to the cost of ownership (Figure 5), it is less desirable when it comes to service persistence and data resistance (Figure 6).

The subsequent what-if analysis shows that even if we change importance of cost of ownership with respect to service persistence and data resistance, the situation does not change at all (Figure 7).

Cloud deployment may be dominant when it comes to price of ownership, especially because it offers an on-demand-pay and pay-per-use models, but the prospect of having your critical business data on some remote server controlled by a third-party, where other users reside next to your virtual environment, makes decision makers and especially CIOs uneasy and weary.

Contrary to Phadnis (2009) statement that hybrid models will be the future (Phadnis, 2009), it is hard to believe that SMEs will follow that track, because hybrid models assume that the maintenance not only concerns one environment, like in case of single-environment deployment, but two; local and Cloud.
While this fact must not necessarily imply that the maintenance costs are higher, it definitely means that the maintenance is much more complicated, while keeping track of all the changes and inter-environment synchronization poses additional problems.

The “hybrid thinking” might contribute to the lower TCO within medium to large enterprises, because their existing ICT infrastructure is robust enough to accommodate two-environment architecture, meaning that the outsourcing of some non-critical elements may by cost-beneficial.

8. Conclusion and further research

With the old vision of computing as a utility becoming a reality the idea of having on-demand, flexible, resource affordable ERP systems for SMEs is not that far away.

Companies want to lower their IT investments, while in parallel increase the benefits. Cloud architecture integrated with localized best practice ERP package may just be the radical solution SME market is looking for and having the possibility of putting some less critical business operations or even all non-critical in the Cloud, can also be interesting for large enterprises.

Having the possibility to use on-demand ERP system with virtually infinite resources, without actually owning it, is a prospect one cannot afford to overlook.

Although according to current market offerings, having a “piece of Cloud” does not relieve its users of ERP maintenance fees, a more compact ERP solution should definitely lower the overall price.

In addition, vendors will have to reinvent their current license and maintenance policies, aligning them more closely with pay-for-use licenses, in order to accommodate the new business model.

The question is not whether ERP systems have the future and if they are going to evolve any further, but what the future will be and in which direction they are heading.

Of all the problems facing ERPs, perhaps the most concerning one for both, vendors and clients, is the implementation; its complexity, cost, adoption cycle and necessity of BPR.

Despite problems mentioned in Tables I and II, and results of the AHP synthesis, there is no doubt that market demands will force innovative vendors to increase their
efforts in finding solutions for obstacles in question, which will set an example for others to follow, perhaps by demonstrating the attractiveness of the new concept to the SME market and even large-scale enterprises.

As the idea of putting various enterprise systems into the Cloud is still relatively young and also current research topic, academics and practitioners alike are encouraged to contribute to the future research of Cloud and ERP integration possibilities.

This research does not aim to answer the question what is the best solution from the standpoint of a particular industry. Instead, it assumes the general approach, which answers the question what would in general be the adequate solution for the SME and how much in general are SMEs ready to adopt the ERP in the Cloud idea.

A further research is necessary in order to validate these results in practice. That research should be industry specific, i.e. narrowed to one industry only, in order to validate results from this study for that particular industry and SME type. Only then it would be possible to give an answer to the question what is the best solution for, e.g. high-tech SMEs.

References


Further reading


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