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A MAGYARORSZÁGI KKV-K ÁLTAL ALKALMAZOTT FELHŐ-ALAPÚ MEGOLDÁSOK ÉS ANNAK HATÁSAINAK ELEMZÉSE

Анотація. *Широкий спектр технологічних інновацій, які відбулися на рубежі тисячоліття і згодом стали загальнодоступними, докорінно змінили співвідношення між інфраструктурою інформаційних комп'ютерних технологій та бізнес-активністю суб'єктів господарювання. Особливо це стосується так званих первинних (вартісних) процесів. Технології, які фундаментально змінюють функціонування суб'єктів господарювання, сукупно називають технологіями «Індустрія 4.0». Однією із значущих груп цих технологій є так звані хмарні технології, завдяки застосуванню яких, користувач використовує переваги, що надаються інфраструктурою інформаційних комп'ютерних технологій через послугу від третьої сторони. Ці послуги можуть бути додатками, доступними через певний онлайн-інтерфейс (SaaS), різними елементами платформи (PaaS, прикладами яких є сервери додатків, віртуальні сервери тощо) або елементами інфраструктури, такими як оренда обчислювальної потужності (IaaS). Використовуючи хмарні рішення, з одного боку, користувач може бути звільнений від капіталовкладень, необхідних для роботи інфраструктури інформаційних комп'ютерних технологій, а також від додаткових проблем, викликаних роботою. На початку 2019 року проведено анкетування, в якому добровільно взяли участь 498 респондентів. У рамках дослідження проаналізовано рівень розвитку інфраструктури інформаційних комп'ютерних технологій серед угорських підприємств малого та середнього бізнесу, відповідні наслідки цього процесу для інформаційної безпеки та те, як керівництво суб'єктів господарювання оцінює внесок інфраструктури інформаційних комп'ютерних технологій в бізнес-успіх компанії. Анкетування досліджувало використання різних хмарних рішень. У публікації здійснено порівняльний аналіз результатів щодо частоти використання різноманітних хмарних рішень із аналогічними дослідженнями, проведеними в цьому напрямку, визначено, чи мають хмарні рішення індивідуально продемонстрований сприятливий вплив на діяльність компанії, а також ефект синергії, коли кілька хмарних додатків використовуються разом. На основі якісних результатів дослідження та після їх опрацювання запропоновано більш широкий аналіз даних процесів.*
Ключові слова: *інфраструктура інформаційних комп'ютерних технологій, Індустрія 4.0, IaaS, суб'єкти господарювання, дослідження, PaaS, SaaS.*

JEL Classification: O32, O33

Absztrakt.. *Az ezredfordulót követő időszakban végbemenő és később általánosan elérhető technológiai innovációk széles köre alapvetően alakította át a gazdálkodó szervetek életében az IKT-infrastruktúra és a üzleti tevékenység viszonyát. Különös tekintettel igaz ez az úgynevezett elsődleges (értékteremtő) folyamatokra. Ezeket a gazdálkodó szervezetek működését alapjaiban átalakító technológiát összefoglaló névvel „IPAR 4.0"-technológiáknak nevezzük. Ezen technológiák egyik jelentős-csoportja az un. felhőalapú technológiák, amelynek alkalmazása révén az igénybe vevő fél egy harmadik fél által nyújtott szolgáltatás révén használja az IKT-infrastruktúra által biztosított előnyöket. Ezek a szolgáltatások lehetnek egy adott online felületen elérhetővé tett alkalmazások (SaaS), különféle platform elemek (PaaS, ezekre példák az alkalmazás szerverek, virtuális szerverek*

stb.), vagy infrastrukturális elemek, mint amilyen a bérelhető számítási kapacitás (IaaS). A felhő-alapú megoldások alkalmazásával egyrészről az igénybe vevő az IKT-infrastruktúra üzemeltetéshez szükséges beruházástól, valamint az üzemeltetés által okozz további problémáktól is mentesülhet. 2019 elején egy kérdőíves felmérésre került sor, amelyben 498 válaszadó vett részt önkéntesen. A kutatás keretében azt vizsgáltam, hogy a magyarországi KKV-k körében milyen fejlettségi szinten áll az IKT-infrastruktúra kiépítése, ennek milyen információ-biztonsági következményei vannak, és a gazdálkodó szervezetek vezetése milyennek értékeli az IKT-infrastruktúra vállalati sikerességéhez történő hozzájárulását. A kérdőívben felmérésre kerültek a különféle felhő-alapú megoldások használata is. A publikációban a különféle felhő-alapú megoldások használatának gyakoriságára vonatkozó eredményeket összehasonlítom a régióban lebonyolított hasonló kutatásokkal, és megvizsgálom továbbá, hogy a felhő-alapú megoldásoknak van-e egyedileg kimutatható jótékony hatása a vállalati működésre, valamint a többféle felhő-alapú alkalmazások együttes használatakor azonosíthatóak-e szinergia hatások. A kutatás kvalitatív eredményei alapján és azoknak az értelmezést követően javaslatot teszek egy szélesebb körű elemzésre.
Kulcsszavak: *IKT-infrastruktúra, Ipar 4.0, IaaS, gazdálkodó szervezetek, kutatás, PaaS, SaaS.*

Abstract*. The wide range of technological innovations took place in the post-millennium period and later became widely available have fundamentally reshaped the relationship between ICT infrastructure and business in the life of for-profit organizations. This is particularly true for the so-called primary (value-creating) processes. These technologies that have fundamentally transformed the way business organizations operate are collectively referred to as "Industry 4.0" technologies. A significant group of these technologies are the cloud-based solutions. By using these solutions, the users can get benefits from the ICT infrastructure through a third-party service. These services can be applications made available on a specific online interface (SaaS), or various platform elements (PaaS, for example: application servers, virtual servers, etc.) or infrastructure elements such as leased computing capacity (IaaS). By using cloud-based solutions, the customer can avoid the investment needed to run the ICT infrastructure and the additional problems rooted by the operation of ICT-infrastructure. A questionnaire survey was carried out in early 2019, in which 498 respondents voluntarily participated. The survey investigated the deployment level of ICT infrastructure among SMEs in Hungary, its information security consequences and how the management of the for-profit organizations evaluate the contribution of ICT infrastructure to the success of their business. The use of different cloud-based solutions was also measured in the mentioned questionnaire. The paper presents the research results of the prevalence of use of different cloud solutions with similar studies in the region. Furthermore, it examines whether cloud solutions have individually detectable beneficial effects on business operations, and whether synergies can be identified when multiple cloud applications are used together. Based on the qualitative results of the research and their interpretation, a broader analysis has been offered.*
Key words*: ICT-Infrastructure, Industry 4.0, IaaS, for-profit organizations, research, SaaS, PaaS.*

Problem statement. Since the mid-2000s, the rapid evolution of the architecture and services in the ICT infrastructure accessible by the for-profit organisations has exerted an impact on the operation of enterprises deploy these solutions [7][11]. These architectural changes have opened a new era, which is now known as "Industry 4.0". Although these technologies associated with "Industry 4.0" are treated in many publications as solution with the same importance [2], I think that the cloud-based solutions should be discussed particularly focused. The emergence and diffusion of cloud-based solutions is important to discuss because it has made it possible to offer to

deliver the benefits of ICT infrastructures as a service for the for-profit organisations that are unable or unwilling to invest in ICT infrastructure development [10].

During using cloud computing services, the providing physical ICT infrastructure is operated by a third partner, not by the user. These services of the cloud-based solutions fall on a very broad spectrum: the simplest form is an application made available on the web (for example: Salesforce), while the most complex service is computing or AI capacity available online (for example: Gcore). These services are used by the user, and depending on the intensity of their use, for a price set as a service via the Internet. There are three main models of service [13]:

- SaaS (Software as a Service): mainly a web-based application is used on a web server of the provider. (In some cases, the online service may be complemented by an offline version that can be installed on the user's computer).
- PaaS (platform as a service): this includes the logical infrastructure required for application development. For example, frameworks needed to develop an own cloud-based software (Microsoft Azure Cloud Platform), online database servers, environments for running artificial intelligence computations.
- IaaS (Infrastructure as a Service): virtual servers (VPS), and CPU, memory or storage capacity that can be leased for various high-performance IT tasks.

The advance of cloud computing solutions needs to be researched for several reasons: on the one hand, it has made many services provided by ICT infrastructure available without the needs of investment. These services delivered by the ICT-infrastructure were previously only available through significant investment. Kaminsky and co-author [6] point out that these cost savings can be achieved by not building a physical ICT infrastructure, by converting software license costs into rental costs, or by reducing the cost of regular maintenance. In additional, the user partner of the cloud service is relieved of problems such as providing the necessary knowledge and expertise to operate. In summary, both the financial and non-financial barriers to entry are removed, giving a more capital-poor business access to innovative technology solutions.

Literature review. Two major issues had to be identified in the literature review: regardless of the fact that it is declared on a theoretical level that cloud solutions are a relatively broad umbrella term and a SaaS-, PaaS or IaaS solution plays a completely different role, unfortunately, the questionnaire surveys of more researches presented in different papers do not make a proper distinction. Such examples the publication of Lisowska-Pamula [9]. The other very serious issue is to look at the adaptation of cloud-based solutions in a wide and complex context. In doing so, the authors refrain from reporting the raw results themselves[5] and focus unilaterally only on drawing conclusions, making the qualitative results of individual studies incomparable[14]. A step forward in the way of approaching this issue is the publication of the Bajdor-Lis [3], in which they studied 47 companies in Poland. The uniqueness of the research is that it assessed how long the respondents had been using cloud-based solutions, and the authors have already distinguished between SaaS, PaaS and IaaS cloud architectures in their research.

The research of Guo et al.[4] is methodologically significant, as their results show that different factors influence the decision of the management of different business organisations to use cloud services with different architectures.

The timeliness of the current publication of the results from the 2018 data collection in my research is partly since Zbořil et al. [16] analysed the uptake of cloud services among enterprises in the Czech Republic based on EUROSTAT data. The authors compare data from the Czech Republic with the averages of the Visegrad Group (further: Visegrad-countries) and EU member states. Although my research is in all respects independent of the EUROSTAT survey, it is fortunately possible to compare the results. Given the fact that data from Hungary were not included in that research [16], I can only compare my own research results with the average of the V4 countries, too. The way the questions used in this research were asked regarding SaaS providers shows many similarities with the research presented here, although the research presented in this publication takes into account SaaS, IaaS and PaaS service models in a balanced way. The study of the advance of cloud-based solutions is also important because Tick et al. [15] found in a recent study that SMEs in Hungary showed a significant lack of awareness of cloud-based solutions. Türkes et al. [17] who found a similar situation in Romanian SMEs, too.

Research aim and objectives. The primary aim of the study presented in this paper is to explore the extent to which cloud-based solutions of different architectures are being adopted by SMEs in Hungary, and whether the adoption of cloud-based solutions has an impact on the success and competitiveness of the company. To the extent possible, I will compare the results of my research with the research[16] identified in the literature review as relevant.

Overview of the research. The analysis presented in this publication is based on the results of a non-anonymous questionnaire survey conducted in two waves (spring and autumn 2019). The data was collected entirely online. The aim of this comprehensive research is to investigate the ICT infrastructure and information security of business organisations in the light of senior management satisfaction and innovation. The sample was drawn from a range of for-profit organisations in Hungary such had at least two closed financial year and clearly do not fall into the category of ’forced entrepreneurs’ so common in Hungary. This would also suggest that they have established a business structure consisting of some kind of stable business processes. The companies (e. g. financial services, financial brokers and insurance companies) were excluded from the that were expected to be required by the regulatory regime to have a sophisticated ICT-infrastructure.

The questionnaire has been developed in accordance with international literature and practice [8][12]. The first version of the questionnaire was developed after the review the relevant source. The draft version of the questionnaire was modified based on the experience collected in the testing of the questionnaire. The final version of the questionnaire contained 78 questions.

Based on the data from respondents' financial statements filed in accordance with Hungarian accounting law in the year of 2018, I examined the distribution of the participants by balance sheet total and employment’s data. (Three respondents report

only according IFRS, so their data were not available in the official databases.) The classification of respondents by balance sheet total and employment's data is presented in Table 1.

Table 1

Characteristics of the companies in the research

		Balance sheet total					
		under 1 million HUF	**1- 10 million HUF**	**10–25 million HUF.**	**25–100 million HUF**	**above of 100 million HUF**	**Total**
Number of employees	**under 10**	90	4	0	0	0	**94**
	11–50	211	41	0	0	0	**252**
	50–250	30	87	5	3	1	**126**
	above 250	1	10	10	2	0	**23**
	Total	**332**	**142**	**15**	**5**	**1**	**495**

Source: own ed.

Table 1 shows that there is a left asymmetry along both dimensions, and the research results are likely to have been heavily influenced by the significant over-representation of both small balance sheet total and relatively small number of employees.

Overviewing at the spatial distribution of respondents' place of residence, the Central Hungary Region is predominant (n=191, 38%), with the other regions relatively evenly represented with a share of 9-12%, with a roughly even distribution. It would have been fortunate if each region had a weighting of 14 ± 1.5% in the survey, so that the regions would have been evenly represented. The Central Hungary region is the most developed NUTS2 administrative unit in Hungary[16], which is one of the reasons why the results presented later are much better than similar studies carried out in the region (Visegrad countries) at the same time.

Respondents were not classified by industry because no database was available that could reliably classify businesses into one or more industries. And from the spot-check analysis I had to conclude that it is not possible to reliably classify respondents into one or more industries based on the records in the official company registration.

Results and discussions. In the research presented in this article, I have included 11 questions from the questionnaire on the systemisation of cloud-based solutions, and 1 question about the perceived benefit on the operational level and 1 question about perceived benefit the strategic benefit of the serviced delivered by ICT infrastructure, as follows:

There were three possible answers for the systemisation of cloud-based solutions: 'yes' / 'no' / 'don't know'. The types of cloud services surveyed in the research fall into 3+1 categories:

- IaaS: cloud-based memory, computing capacity, and virtual server.
- PaaS: application server, cloud database service, and block-based (high capacity) storage
- SaaS: custom applications, file-based storage capacity, enterprise management system, and business intelligence solution.

- Other: solution not classified and not mentioned by respondents in the previous three categories.

A question related to an email server as a cloud service was not included in the survey. The only reason is that it could not be guaranteed that respondents would be able to distinguish between using a free email service and using an enterprise mail server as a SaaS-service.

I measured satisfaction with the ICT infrastructure with two control questions. Both questions were answered on a Likert scale from 1 (worst) to 5 (best):

- Perceived benefits on operational level of ICT infrastructure services: out of 498 respondents, 35 responded with 1 (7.02%), 34 responded with 2 (6.82%), 104 responded with 3 (20.88%), 173 responded with 4 (34.73%) and 152 responded with 5 (30.52%). The average response was 3.74.
- Perceived benefits on strategical level of ICT infrastructure services: of the 498 respondents, 52 responded with 1 (10.44%), 83 responded with 2 (16.67%), 137 responded with 3 (27.51%), 143 responded with 4 (28.70%) and 83 responded with 5 (16.67%). The average response rate was 3.24.

The distribution of responses to these two questions shows that it has indeed been possible to measure different dimensions of satisfaction with the services provided by the ICT infrastructure. Of these two responses, the first measures operational benefits, while the second measures strategic benefits. After these observations, let us review the responses received for the use of each cloud service (Fig.1.):

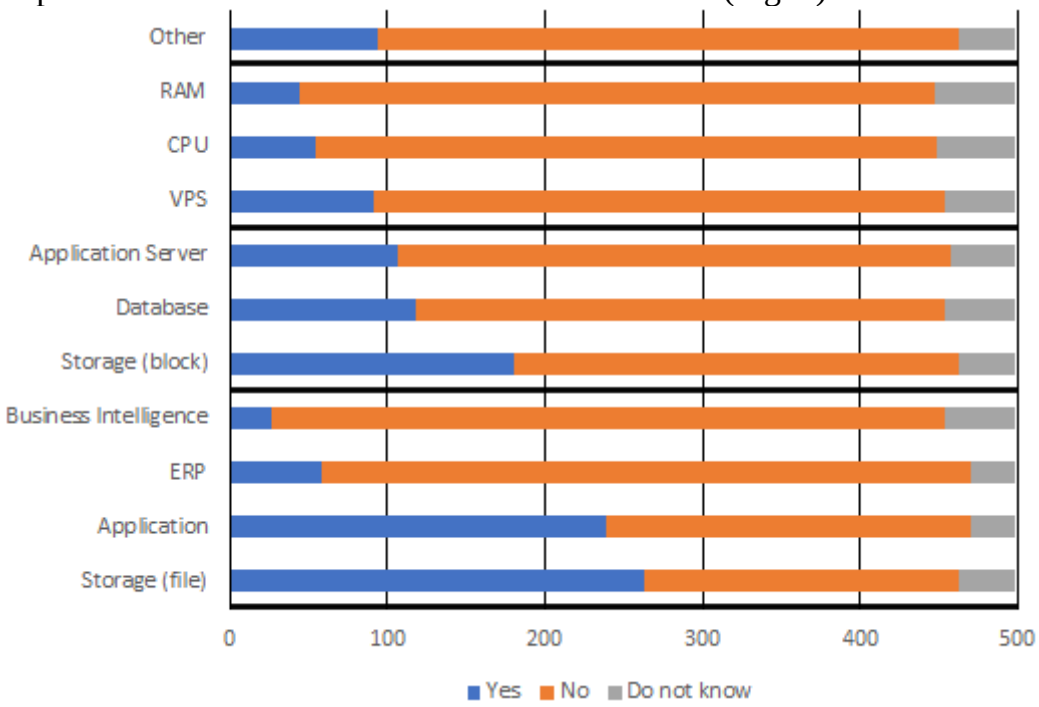

Fig. 1. Use of Cloud-based services by Hungarian SMEs

Source: own ed.

I think it is a significant pattern that the "I don't know" response for each cloud service ranged from 5-10%. This suggests that this is the maximum percentage of people who are not familiar with the service, as a clear yes or no answer assumes that

you are familiar with the service. The data shows that the take-up of SaaS services is much wider than that of PaaS services, and that the take-up of PaaS services is higher than that of IaaS services. At this point, however, it should be noted that many SaaS services are partly or entirely free (e.g. Dropbox or Google services.) Comparing the results of my research with those of [19], it can be concluded that, in general, the uptake of cloud services appears to be higher in the research I conducted. The results of Zbořil-Svatá in 2018 showed that the average in the V4 countries was 29%, while my research resulted in 76.9%. (Although it should be noted that in my research, far fewer respondents answered.) Also comparable are the responses on cloud storage services, although I have split them into two cases: on the one hand, typically low-capacity (and therefore often free) file-based services and, on the other hand, high-capacity block-based services. This suggests that in 2018, in contrast to the average for the Visegrad-countries, block-based storage services reached this proportion, with the much more popular file-based service exceeding 50%. A much smaller proportion, but similar, can be said for cloud-based databases (23% as shown by me compared to 12% in the Czech research).

There were 3^{11} = 177,147 variations of responses to the 11 cloud service responses. Of these, the most common response, 115, was that although they were aware of all cloud services, they did not use any of them. Pattern analysis was not possible because the 498 respondents gave 235 patterns for cloud solvers. Of these, there was one case where the number of respondents exceeded 100, six cases where more than 10 respondents followed the same pattern, and a further 37 cases where more than 1 but fewer than 10 respondents gave the same answers. Based on these results, I summarise in the following graph the extent to which customers are using each of the 11 cloud services. (It is not a typo that there are 134 respondents who do not use any of the cloud services. The 115-figure mentioned earlier shows those who clearly said no to all. The 134 also includes those who answered ‘don't know’) Given these facts, it is worth reviewing how many respondents use 1, 2, ..., 11 cloud services (Fig.2.):

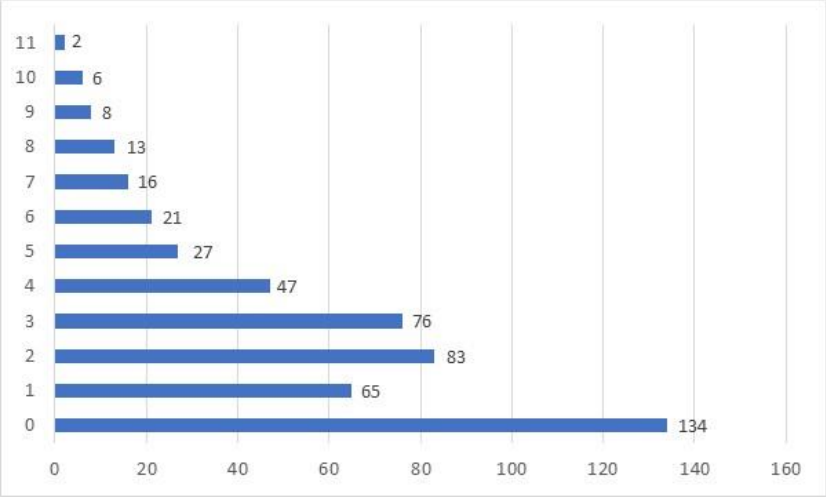

Fig. 2. Intensity of the use of Cloud-based solutions

Source: own ed.

In order to be able to evaluate these data, it is necessary to examine whether each Cloud-based solution provides measurable added value on an operational and/or strategic level for the business organization using the given technology (2. Table):

Table 2

Added value of cloud-based solutions at operational and strategic level

			Satisfaction with operational benefits (average)	Satisfaction with strategical benefits (average)
N / A	Other	No	3,68	3,12
		Yes	3,89	3,64
IAAS	RAM	No	3,72	3,14
		Yes	3,88	3,78
	CPU	No	3,70	3,13
		Yes	4,04	3,73
	VPS	No	3,65	3,09
		Yes	4,12	3,75
PAAS	Application Server	No	3,67	3,09
		Yes	3,87	3,55
	Database	No	3,66	3,08
		Yes	3,95	3,55
	Storage (block)	No	3,62	3,06
		Yes	3,96	3,53
SAAS	Business intelligence	No	3,70	3,16
		Yes	4,15	3,85
	ERP	No	3,68	3,14
		Yes	4,28	3,88
	Application	No	3,46	2,94
		Yes	4,03	3,52
	Storage (file)	No	3,60	3,01
		Yes	3,87	3,38

Source: own ed.

In a review of the data, it can be concluded that the use of cloud-based solutions has in all cases, varying degrees, contributed to respondents' better appreciation of the added value of ICT infrastructure at both operational and strategic levels. In all cases this improvement was more intense at the strategic level. Since these results, I will finally examine whether synergies can be demonstrated when several cloud solutions are used together (Table 3):

Table 3

Synergies of cloud-based solutions

Number of cloud solutions in use	Satisfaction with operational benefits (average)	Satisfaction with strategical benefits (average)
0	3,68	3,12
1	3,83	3,35
2	3,82	3,22
3	3,93	3,21

4	3,70	3,36
5	4,07	3,56
6	3,95	3,57
7	4,38	4,19
8	4,00	3,77
9	4,13	4,00
10	4,33	4,33

Source: own ed.

The results summarized in Table 3 show that satisfaction with ICT infrastructure (both in its operational dimension and in its strategic dimension) increases as respondents use more cloud services. (That is, synergy effects have been shown to exist.) This increment is not strictly monotonic, and a sort of "glass wall" is discernible, i.e., even for the most extensive range of cloud service usage, it does not reach or approach 5.00. There are several possible explanations for this, but in context I take the view that this phenomenon highlights the fact that cloud-based solutions are not yet a 100% substitute for the classical ICT infrastructure.

In the light of these results, a comprehensive, qualitative evaluation of the results can be carried out.

Conclusions and prospects for further research. I have pointed out in the literature review, and it is clear from the answers to the relevant questions in my questionnaire, that cloud-based solutions should not be considered as a homogenous group of different services. That is, at least, cloud solutions should be differentiated between SaaS, PaaS and IaaS solutions, but if we consider the data in Figure 1 and Table 2, further research can only arrive at an accurate result if the different types of cloud solutions are analysed in detail. The relatively high yes rate for other types of cloud solutions indicates that the 10 categories I used were far from exhaustive, so a repeat study will need to expand this scope. At the very least As I pointed out earlier in the article, the data on the relative prevalence of some cloud services in my research is higher than the averages for the Visegrad countries - in several cases the results are better than the data from the Czech Republic. This phenomenon can be explained by several factors: the sample was basically drawn from more mature organisations, and on the other hand, most respondents are from the most developed region of Hungary. The fact that no distinction was made between free and paid services, and that I did not consider possible bundling: many SaaS solutions include a rental fee not only for the use of the software but also for free file-hosting (such solutions are offered by Microsoft, Adobe and Cyberlink etc.)

In the sub-study presented in this paper, I have demonstrated with statistical data that cloud-based solutions contribute to the performance of business organisations at both operational and strategic levels. In addition, I have confirmed the synergies between each cloud solution.

Based on further questions of the questionnaire - not presented in this publication - it is possible to analyse the reasons and barriers for the adoption of cloud-based solutions using the well-known Technology - Organisation - Environment framework [1]. If a successfully set up TOE model is complemented with the satisfaction data

presented in this publication and additional satisfaction data, it would be possible to identify exactly which IT and business problems are optimally addressed by a move to a cloud-based service.

This research has only investigated the uptake of so-called public-cloud based services, but it would be important to complement the present research with the dimension private vs public cloud. Such an analysis would give us a more accurate picture of the transformation of the ICT infrastructure, its new possibilities and the information security issues it raises and which were previously unknown.

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