ICT Profiles of Russian Companies at the Industry Level: Resource Management Strategies

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Abstract

The study investigates the Russian information and communication technologies (ICT) landscape with a focus on sustainable ICT combinations at the industry level. The ICT combination for a company reflects its ICT profile, which is considered in resource theory as the firm's ability to create competitive advantages based on resource complementarity. Unlike previous papers, it is not an expert-specified combination of ICT that is being studied, but a tool for the automated search for interconnected technologies based on machine learning methods is proposed, which makes it possible to identify stable combinations implemented simultaneously by several companies in a certain industry. ICT profile identification was conducted based on the analysis of relationships across a wide range of IT, from basic infrastructure to AI-based business efficiency management systems. The final dataset includes 110 IT technologies for over 29,000 companies from 31 industries spanning from 2006 to 2022. The following conclusions were drawn: (1) a typical profile for most industries consists of a combination of business process management (BPM) and software as a service (SaaS), (2) insurance and finance industries are the leaders in the diversity and complexity of ICT profiles, (3) supplementing ICT profiles with AI-based solutions holds great potential for Russian companies, (4) the implementation of ICT profiles is linked to companies' financial performance; however, these relationships vary significantly across industries.

Keywords: ICT; sustainable combination of ICT; industry; productivity; profitability

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Introduction

Information and communication technologies (ICT) make a critical contribution to the digitalisation of the economy, while their efficient application is a vital condition for economic growth (Karim et al., 2022). Numerous studies demonstrated the important role ICT play in the development of countries (Habibi, Zabardast, 2020) and companies (Chae et al., 2018; Li et al., 2022), along with such traditional factors as labour and capital.

ICT refers to a very wide range of technologies from basic infrastructure to artificial intelligence-based business performance management systems, leading to the high variability of corporate ICT architectures. Recent studies highlight the growing importance of ICT in the implementation of advanced solutions such as cross-cutting AI technology (Agarwal et al., 2021; Enholm et al., 2022; Dumas et al., 2023), and the shortcomings of traditional approaches to assessing their effectiveness. E.g. when ICT investment data is summarised (Mithas, Rust, 2016), or the contribution of particular technologies is assessed (HassabElnaby et al., 2012; Daviy, 2023), correlation between these technologies is often ignored. Problems with ICT integration are major barriers hindering effective implementation of new technologies (Xue et al., 2005; Amid et al., 2012; Coşkun et al., 2022). Empirical studies increasingly reveal insignificant or even negative impact of certain ICTs on company performance, attributing this to the waste of relevant costs due to various circumstances or particular combinations of resources.

Few previous empirical studies attempted to take into account the heterogeneity of ICTs, and assess their overall performance. This is largely due to the lack of detailed corporate data on ICT adoption, since its disclosure could be used by competitors to their advantage. Some studies (Hendricks et al., 2007; Oh, Kim, 2023) did consider the benefits of applying several ICTs in combination, but the lists of analysed technologies were drafted by experts, and thus may not reflect the actual practices. The analytical approach based on considering not just individual ICTs, but their combinations was implemented in (Wu et al., 2015; Geum et al., 2015): the authors searched for association rules, which allows to objectively identify technology combinations based on actual data.

The goal of this paper is to identify stable ICT combinations, or ICT profiles applied by Russian companies, and assess their effectiveness on the basis of financial indicators. Another objective is to consider the identified ICT profiles in terms of their potential for implementing AI-based solutions. By a stable ICT combination we mean a set of technologies simultaneously implemented by multiple companies. To describe the situation with ICT implementation as thoroughly as possible, e.g. in a particular industry, we identify three types of ICT profiles which can potentially make the greatest impact on the company's performance. Firstly, it's the most common combination of ICTs without which companies supposedly won't be able to do business. E.g. existing studies show that if a company doesn't apply Enterprise Resource Planning (ERP) technology, its use of other resources will be less than efficient (Shakina et al., 2022). The second ICT profile type comprises the widest range of technologies, indicating a high technological level and penetration of ICTs into various aspects of business. The broader the scope of an ICT profile, the more likely the company to be an ICT leader, which serves as a source of its competitive advantage (Chae et al., 2014). Thirdly, ICTs must be industry specific (Jacobsson et al., 2017).

The identified ICT profiles allow to comprehensively describe commonly used ICT combinations as the basis for developing multi-technology solutions for companies in particular industries. Also, analysing the technology combinations companies need to operate smoothly allows to identify the ICTs adopting which is critical in terms of withstanding market shocks. For Russian companies, the departure of many major foreign vendors such as SAP, Oracle, or Microsoft certainly became a major shock. Also important is to identify commonly used inefficient ICT profiles, to prevent the application of outdated technologies or avoid systemic ICT integration problems.

ICT combinations through the prism of the resource approach

Theoretical studies of ICT systems usually tend to apply the resource-based approach (Barney et al., 2001), which defines ICT as companies' strategic resources for obtaining a competitive advantage. Fundamentally important here is not so much the availability of valuable and unique resources as the organisation's ability to combine them on the basis of their internal potential and availability. Finding the optimal combination of resources to achieve a synergy from their use is a key objective of present-day management (Teece, 2018; Shakina et al., 2022). In this regard, ICT in general, and specific systems in particular are seen as parts of the company's resource portfolio, to be used jointly with its other parts. However, only a small number of studies are focused on the complementarity of specific ICTs (Geum et al., 2015; Wu et al., 2015; Díaz-Chao et al., 2021), while the ability to intelligently combine them in a single corporate portfolio becomes a source of competitive advantage (Geum et al., 2015).

In this paper we consider ICT combinations as profiles comprising technologies simultaneously applied in the course of company operations. In the scope of the resource-based approach, an ICT profile is a combination of resources reflecting the organisation's strategic ability to manage its competitive advantages. The decision to use multiple technologies can be driven by a variety of factors.

An ICT profile can be a key resource combination underlying a business model, and a source of profit for the company (Teece, 2018). Several complementary ICTs can be applied to accomplish production-related objectives in a more efficient way. It should be noted that the technologies' relationship in the scope of a profile doesn't necessarily have to be of a complementary nature: some of them may be related to other company resources, generating synergies with them. Good examples of such complementarity are the implementation of ICT systems such as ERP and BI (Gupta et al., 2019), or the combination of IoT and BigData. In recent years, individual ICT systems' functionality was steadily extending due to the use of AI. E.g. CraftTalk's BSS Digital2Speech integrates AI into an ICT profile which includes CRM, biometric identification, and speech technologies.

Three vectors of complementing existing ICT systems with AI are generally seen as the most promising ones (Enholm et al., 2022):

1) computer vision: image, photo, and video recognition, analysis, and classification;
2) natural language processing: text generation, sentiment analysis, and perception of information created by others;
3) machine and deep learning: clustering, classification, and integration into recommendation systems.

Companies' choice of an ICT profile is largely determined by the specifics of their industry. The differences are related to the role of ICT in particular industries (Jacobsson et al., 2017; Chae et al., 2018): in some, ICT provides an alternative to human labour, i.e. it's applied to automate business processes; in others it plays an informational role providing data and supporting management decisions; in others still, it performs a transformational function, fundamentally transforming business models, industry mechanisms, and the interaction of economic agents. An additional argument in favour of the suggested approach is the different levels of industries' digitalisation, clearly reflected in statistics.

Industry affiliation allows to assess the impact of companies' ICT profiles on their performance. Evaluating profiles' effect is similar to measuring the costs and benefits of using ICT capital, or individual ICT systems. The risks associated with using several resources simultaneously include system incompatibility, different time required to integrate them into the company's infrastructure, different support modes, etc. (Coşkun et al., 2022). A review of empirical studies shows that the productivity of ICT combinations was analysed without taking into account industry specifics, while the actual combinations were suggested by experts (such as, e.g., ERP or BI). Given the theoretically substantiated contribution of ICT profiles to companies' competitive advantage, there is a need to test these profiles' impact on company performance in various industries. This, in turn, implies evaluating the use of ICT profiles in relevant industries, namely how many companies use a particular profile, i.e. how common is a particular combination of technologies.

At the industry level, we distinguish three ICT profile types: typical, complex, and specific. The first refers to the most common ICT combination in the industry; the second, to the biggest and most widely used combination, i.e. the one comprising the largest number of technologies and applied by the largest number of companies operating in the industry; the third type reflects a unique combination of technologies not encountered in other industries. Typical profiles act as a kind of industry standard; complex ones are applied by companies implementing innovative ICT strategies (Devece et al., 2017); specific profiles can be used to accomplish unique objectives arising in a particular industry. In the practical part of our study, all three profile types will be assessed in terms of the potential to extend ICT functionality with the help of AI.

Research methodology

An AI tool was used to identify stable ICT combinations: an algorithm for searching for association rules, proposed by (Agrawal et al., 1993) and actively applied in various sectors of the economy including the financial sector (Batarseh et al., 2021; Kaur, Dharni, 2022). Essentially, the algorithm searches for association rules of the kind "the company implemented both ICT *X* and ICT *Y*" (Hegland, 2003). Quality metrics (support, confidence, and lift) can be calculated for each rule, based on the frequency of its (or its individual elements) occurrence in the available data array. However, each rule has certain specifics.

1) ICT *X* support is the share of companies in the sample which have implemented technology *X*; in a way it shows how frequently the technology is used, or its popularity; rule X→Y support is the share of companies which have adopted both ICT *X* and ICT *Y*.

2) Rules' credibility is calculated as the ratio of rule $X \rightarrow Y$ support to the share of companies which have implemented ICT X; it reflects the probability of adopting ICT Y if ICT X has already been implemented.
3) The rule's lift, or the metric of its importance, reflects how often the share of companies which have implemented both ICT X and ICT Y exceeds the share of expected implementations when there is no correlation between adopting ICT X and ICT Y; if this metric's value is greater than 1, it means ICTs X and Y complement each other. In line with our hypothesis that ICT profile should comprise complementary technologies, only association rules with the lift value above 1 were considered in the further analysis.

At the next methodological step, the *Apriori* algorithm (Agrawal et al., 1994) was applied: it's a classic mechanism for sorting out a set of possible association rules. It's a part of an integrated strategy for selecting potential candidates for inclusion in stable association rules, the so-called. apriori principle (Hegland, 2003). The result significantly depends on the threshold values set for the support and credibility metrics: if they are close to 0, the algorithm will identify a large number of rules which, on the one hand, might make the subsequent analysis labour-intensive, but on the other, reveal productive and non-trivial stable rules. If the threshold values are set close to the upper limit, the algorithm will work faster and yield a small number of rules; however, these may turn out to be banal and self-evident (Hegland, 2003; Hikmawati et al., 2021).

No universal algorithms for determining optimal threshold values have been developed yet. In most cases researchers set them empirically for each particular task, taking into account the sample size and the maximum number of rules they are willing to process (Kotsiantis, Kanellopoulos, 2006). E.g. it was experimentally demonstrated that for different data on different domains, optimal support threshold values can vary between 0 and 60% (Hikmawati et al., 2021). However, several patterns emerge here: the larger the data array, the lower the support threshold value should be; and the broader the range of ICTs, the lower the support and credibility thresholds should be set.

As a starting point for setting minimum optimal support and credibility levels, we followed the logic of previous studies in a related research area. E.g. (Wu et al., 2015) set the support threshold at 10%, and (Geum et al., 2015) at 3%; the credibility thresholds were set at 50% and 40%, respectively. Because our sample covers a broader range of ICTs than in previous studies, lower threshold values can be used. Empirically, we settled on 1.5% for the support metric, and 25% for credibility.

An important criterion for searching for associative rules of ICT application is the period during which ICTs should be considered as applied by the company together. A short period (e.g. 1 year) will yield a small number of such combinations; while setting a too long duration would increase the risk the combinations would comprise already abandoned technologies which have not actually been used in conjunction with each other. Therefore using a "sliding window" to cover the period of technology application appears to be a more effective approach. Its duration should be set taking into account the rate of ICT systems' implementation, and their service life in the relevant industry. Since in this study the average observation period for companies' activities was 1.5 years, the search for association rules was carried out for its entirety.

To validate the identified ICT profile types, and assess the effectiveness of existing industry practices, we measured the impact of adopting such profiles on company performance. The following fixed effects model was applied, for each industry separately:

$$y_{i,t,s} = \alpha_{0,s} + \alpha_{1,s} * size_{i,t-1,s} + \alpha_{2,s} * leverage_{i,t-1,s} + \sum_{j=1}^{k} \beta_{j,s} * Profile_{j,i,t,}s + \psi_{i,s} + \mu_{t,s} + \epsilon_{i,t,s}, \quad (1)$$

where y is performance indicators of company i in industry s in year t, with $s = 1.31$.

Labour productivity and profit margins were used as company performance indicators. Since implementing and combining technologies requires significant investment, their impact on labour productivity was seen as an intermediate indicator, and on profit margins as resulting one. Therefore equation (1) was calculated for the relevant company performance indicators separately for each of the 31 industries. In such models, company size $sise_{i,t-1}$ (in our case, the logarithm of company assets was applied as a proxy for this indicator), and financial leverage $leverage_{i,t-1}$ (calculated as the ratio of borrowed capital to company assets) are most often used as control indicators (Enekwe et al., 2014; Zavertiaeva et al., 2020). Control indicators were applied with a one-year lag, to address the potential reverse causality problem (Bellemare et al., 2017; Hill et al., 2021). To take into account individual characteristics of companies and macroeconomic conditions, company and yearly fixed effects were also added to the equation, denoted as ψ_i and μ_t, respectively.

The variable $Profile_{j,i,t}$ coefficient is of key interest. This variable reflects the application of the j-th ICT profile by the i-th company in the year t. Technically, it's a dummy variable that takes only two values: 1 and 0. The index k denotes the number of ICT profiles in the industry; generally there are three: specific, complex and typical. Since it was not possible to identify a specific ICT profile for certain industries, the index *k* for them was set to 2. The coefficient reflects the contribution of profile *j* to company performance $y_{i,t}$.

Empirical basis of the study

To check the presence of stable relationships between ICTs, a database was created comprising more than 29 thousand companies operating in 31 industries, which implemented ICT systems in 2006-2022. TAdviser was used as the main data source - the largest aggregator of news about ICT manufacturers, the actual technologies, and their implementation in Russia. The data was supplemented with information from company websites. The analysis covered more than 100 technologies. The list of those included in the ICT profiles of Russian firms is presented in Appendix 1.

Data analysis showed that on average, Russian companies use two ICTs, although the maximum per company number, e.g. in the financial industry, can be as high as 71. In general, we can note a high heterogeneity of domestic businesses in terms of the number of ICTs implemented. Despite the long observation period, the average per company duration was 1.5 years. The effect of using particular ICT profiles was assessed on the basis of available SPARK system data, taking into account the comparability of data from different sources. Table 1 presents descriptive statistics on financial indicators by industry, included in the model described by equation (1).

Identified ICT profiles of Russian companies

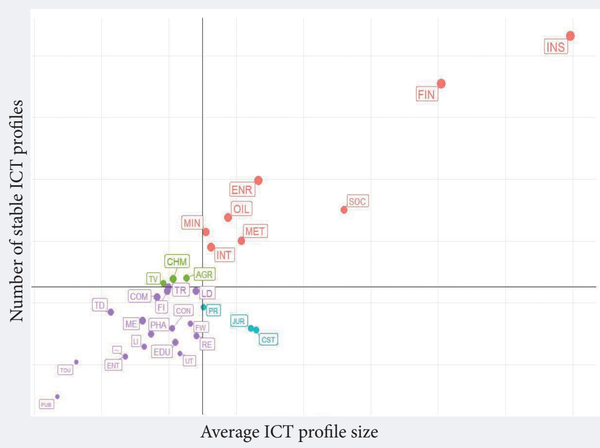
ICT profiles of Russian companies operating in various industries were identified with the help of the association rules method. The matrix presented in Fig. 1 reflects the characteristics of various industries' technology landscape in terms of the average diversity and complexity of applied ICT profiles. Diversity was measured as the number of stable technology combinations, and complexity as the size of the ICT profile, i.e. the number of technologies used in combination with each other. The circle size on the graph below reflects the technological level of the relevant industry derived from the average number of ICTs applied per company.

The high diversity and complexity of the applied ICT profiles may be evidence of a developed industry ICT architecture. The undisputed leaders by this criterion are insurance (INS) and financial services (FIN). The same quadrant also includes public administration (SOC), steam, gas and electricity supply (ENR), oil production and refining (OIL), metallurgical production (MET), ICT (INT), and mining of other minerals (MIN). At the opposite end are the industries with homogeneous ICT profiles comprising a small set of technologies: activities of public organisations (PUB), hospitality (TOU), etc., located in the lower left-hand quadrant of the matrix (Fig. 1). Despite the apparent positive relationship between the diversity and complexity of ICT profiles at the industry level, one can see that two industries have predominantly homogeneous profiles comprising a wide range of ICTs, namely management consulting (CST) and legal services (JUR).

In the course of further analysis, ICT profile types were considered. Table 2 presents ICT combinations for each industry, which reflect ICT profile categories. Additional analysis of the use of AI-based solutions allowed to identify industries and ICTs already using such tools. In Table 2, AI-based ICTs are shown in italics (if the industry companies use relevant products). For some industries, no unique stable combination was found, i.e. they have no industry-specific profile.

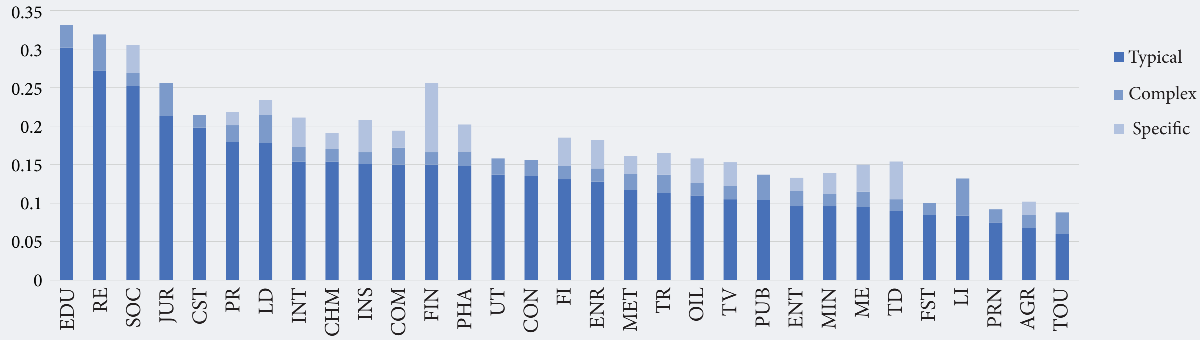
Cross-industry comparison of the identified ICT profiles reveals similarities in technology application (in particular, BPM, CRM, EDMS and SaaS) due to their general-purpose nature. E.g. many companies strive to automate client serving operations and implement CRM systems; almost all of them use EDMS; many have a need to optimise business processes with the help of BPM systems; the SaaS format offers numerous software products provided through outsourcing, including cloud

Figure 1. **Diversity and Complexity of Applied ICT Profiles**



Source: authors.

Figure 2. **ICT profile application by industry**



Source: authors.

computing. However, the above solutions are combined with industry-specific complementary technologies. In the oil industry, it's satellite communications and navigation which may be required because oil fields are frequently located in remote areas; in the public sector it's data mining, since government organisations often deal with citizen requests which are a source of large amounts of data. The combined use of management technologies (ERP, WMS, HRM, CRM) and data analysis (BI, data centres, big data) should also be noted. The above-mentioned technologies are integrated to support corporate decision-making.

The adoption rate of ICT profiles significantly varies between industries (see Fig. 2). E.g. in education, typical profile is implemented by 30% of organisations, while in mining of other minerals only by 6%. Other profile types are implemented much less frequently: complex profiles by between 1.5% and 5% of companies, and specific profiles are applied only in 20 industries (the largest share (9%) was found in financial services).

Analysis of the implementation of AI-based solutions by domestic companies revealed that not all ICT profiles comprise such tools, which indicates they have a high potential to promote digitalisation of Russian businesses. The leaders here are financial services, investments, and audit; these industries have implemented about 40 EDMS projects (stream recognition systems, EDS-SRS). According to the TAdviser portal, most such solutions on the Russian market are supplied by Smart Engines. Integrating AI tools into BPM systems has good prospects. We did not find in the publicly available sources any information about Russian companies which have actually implemented such solutions, but AI-supplemented BPM systems are available on the market (e.g. Sherpa RPA by Sherpa Robotics). Such tools allow to adapt and improve business processes by making them context-sensitive, and facilitate human-machine interaction (Dumas et al., 2023).

Effect of ICT profiles' application, by industry

The impact of ICT profiles on companies' profit margins and productivity was measured in line with equation (1). The calculations show that the correlation between using a typical ICT profile and profit margins is non-linear. Figure 3 presents data on the significant correlations between various ICT profile types and firms' profit margins, normalised to the industry average.

If in ICT industry, oil industry, and public administration the correlation under consideration is positive, in metallurgy, telecommunications, construction, and production of consumer goods it's negative. The negative impact can be explained by the widespread use of outdated or poorly integrated technologies, so upgrading ICT seems to be a most relevant task for these industries. The success of leading metallurgical firms is largely due to the implementation of the entire range of ICT profile technologies, which provides a good example for companies using ineffective typical profiles. However, in real estate, mining, and ICT the latter profile type turned out to affect company performance positively.

As to complex ICT profiles, a positive correlation with companies' profit margins was established in metallurgy, transport, healthcare, and energy, though the introduction of these technologies does

Table 1. **Average values of key variables for the sample, by industry**

Industry	ROS, %	Productivity, *million roubles/person*	Leverage	Assets, *million roubles*
Maintenance of buildings and premises	1.73	28.94	2.26	6519.80
Creative activities (arts and entertainment)	1.74	12.45	2.08	5219.16
ICT	12.71	12.87	0.50	13446.05
Management consulting	5.39	11.74	1.27	2779.34
Light industry	6.17	20.21	1.62	4016.07
Warehouse services	7.50	26.66	1.78	17055.34
Manufacturing of machinery and equipment	2.86	17.07	1.65	16467.56
Metallurgical production	4.32	15.64	1.78	41925.21
Real estate operations	7.28	171.16	13.35	58632.51
Oil production and refining	8.09	36.55	1.20	146273.52
Education	9.27	4.94	0.16	3445.40
Activities of public organisations	5.96	1.63	0.43	8957.94
Food production	4.85	15.59	1.92	8189.67
Publishing	7.81	7.48	1.28	2919.09
Advertising	8.83	27.43	2.54	3043.29
Agriculture	5.62	16.05	0.38	8563.28
Telecommunications	5.66	17.49	3.66	17830.27
Insurance	18.67	44.21	0.54	668588.91
Construction	3.68	26.81	2.00	13558.71
Production of consumer goods	4.64	14.88	1.33	5895.65
Trade	2.64	74.66	1.92	24118.76
Public administration	14.21	4.82	0.03	30318.63
Transportation and storage	7.39	33.41	1.86	19915.37
Hospitality	18.84	7.57	2.09	741.13
Healthcare	7.52	21.77	1.01	10625.07
Financial services	8.05	131.80	5.59	45617.59
Chemical production	8.43	13.04	1.20	15696.13
Steam, gas and electricity supply	3.13	24.80	0.98	28610.29
Legal services	15.68	10.67	0.66	2773.82
Mining of other minerals	6.08	18.00	1.71	70840.78
Total for the sample	**7.49**	**29.01**	**1.96**	**1302584.36**

Source: authors.

not affect productivity (except in the construction industry). Therefore one can assume that improved performance is due to reduced costs and better decisions, not to personnel layoffs.

Analysis of specific industries revealed that in metallurgy, the typical profile technologies (BPM and SaaS) are included in the complex one, which comprises BPM, SaaS, CRM, and EDMS. This emphasises the advisability of adopting the latter two technologies for metallurgical firms. This result may be explained by the fact that better-performing companies have more financial resources to implement the technologies in question. In healthcare and energy, the situation is somewhat different: there's no negative correlation between profit margins and the use of typical profile which combines such core technologies as video conferencing and SaaS. More successful players in addition to SaaS also use management tools. In healthcare the relevant technologies are BPM, CRM, EDMS, while in the energy sector it's ERP, HRM, EDMS, and EDMS-SPR. I.e. in these industries the most common, the typical profile comprises a set of necessary technologies, which, on the other hand, does not allow firms to get ahead of their competitors. A similar situation is observed in the transport sector, where the typical ICT profile comprises safety and vehicle control technologies, satellite communications and navigation, the use of which does not affect profit margins (unlike the adoption of complementing systems such as TMS, logistics information system, and FMS which makes a positive impact on this indicator).

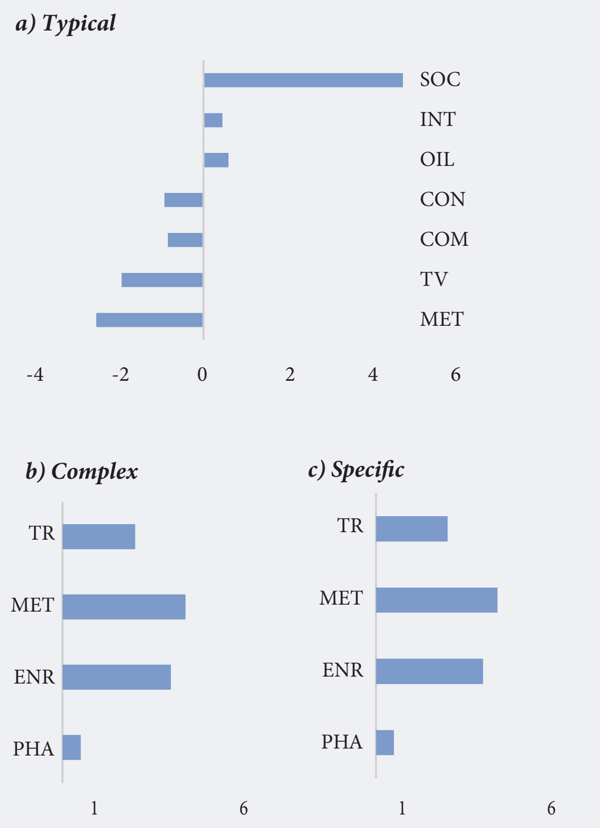
In the ICT industry, the typical profile includes BPM and SaaS, and its use is positively corelated with both company productivity and profitabil-

Table 2. **ICT profiles by industry**

Industry	Code	Typical	Complex	Specific
Maintenance of buildings and premises	UT	BPM, SaaS	BPM, CRM, SaaS, EDM	
Creative activities (arts and entertainment)	ENT	BPM, SaaS	BPM, HRM, SaaS, EDM	VSS, PACS
ICT	INT	BPM, SaaS	BPM, CRM, SaaS, IS, DC	Cloud Computing, IaaS, PaaS
Management consulting	CST	BPM, SaaS	BPM, CRM, ITSM, SaaS, EDM	
Light industry	LI	BPM, SaaS	IS, EDM, SRS	
Forestry and forest industry	FST	SaaS, WMS	BPM, ERP, SaaS, EDM	
Warehouse services	LD	WMS, LIS	TMS, LIS, BPM, FMS, SCN	BPM, SaaS, WMS
Manufacturing of machinery and equipment	ME	BPM, SaaS	BPM, CRM, SaaS, EDM	PDM, PLM
Metallurgical production	MET	BPM, SaaS	BPM, CRM, ITSM, SaaS, EDM	BI, EAM, ERP
Real estate operations	RE	BPM, SaaS	BPM, HRM, SaaS, EDM	
Oil production and refining	OIL	ERP, SaaS	TMS, BPM, FMS, SCN, EDM	ERP, SCN
Education	EDU	SaaS, WMS	BPM, HRM, SaaS, EDM	
Activities of public organisations	PUB	SaaS, WMS	BPM, CRM, SaaS	
Food production	FI	ERP, SaaS	CRM, ERP, ATS, accouting systems	CRM, ATS
Publishing	PRN	ERP, SaaS	Call centres, CMS, CRM, accounting systems	
Advertising	PR	BPM, SaaS	BPM, CRM, ITSM, SaaS, EDM	CRM, HRM, PMS
Telecommunications	AGR	BPM, SaaS	ITSM, SaaS, IS, ICT outsourcing	Server platforms, data centres
Agriculture	TV	BPM, SCN	TMS, LIS, VST, FMS, satellite communications and navigation	Robotics, RBL
Insurance	INS	BPM, EDM	BI, CPM, CRM, ERP, HRM, IS, corporate portals, EDM, accounting systems	Corporate portals, SRS
Construction	CON	BPM, SaaS	TMS, VST, FMS, satellite communications and navigation	
Production of consumer goods	COM	ERP, SaaS	BI, Data Mining, Data Quality, OLAP	BI, OLAP, WMS
Trade	TD	BPM, SaaS	SCM, SRM, WMS	WMS, ATS
Public administration	SOC	SaaS, WMS	BI, Big Data, BPM, Data Mining, ERP, SCM, SRM	Digitalisation of public administration, corporate portals
Transportation and storage	TR	VST, SCN	TMS, LIS, BPM, FMS, SCN	Call centres, OSS/BSS
Hospitality	TOU	ATS, accounting systems	BPM, SaaS, EDM	
Healthcare	PHA	SaaS, WMS	BPM, CRM, SaaS, EDM	ERP, MIS
Financial services	FIN	BPM, SaaS	BI, CRM, SaaS, BI, ICT outsourcing, RBS, EDM	SaaS, RBS
Chemical production	CHM	ERP, SaaS	BPM, CRM, SaaS, EDM	MES, WMS
Steam, gas and electricity supply	ENR	SaaS, WMS	ERP, HRM, SaaS, EDM, SRS	ERP, Automated commercial electricity metering system
Legal services	JUR	BPM, SaaS	BPM, CRM, ITSM, SaaS, EDM	
Mining of other minerals	MIN	SaaS, EDM	BI, ERP, HRM, SaaS, EDM	ERP, LIS

Source: authors.

Figure 3. **Normalised assessment of the impact of companies' ICT profiles on their profitability, by industry**



Source: authors.

ity. This technology combination supposedly contributes to more efficient use of human resources. Adoption of typical profile in real estate (BPM and SaaS) and mining (EDS and SaaS) increases productivity even compared to companies implementing more advanced complex profiles. However, a more efficient use of labour resources does not lead to increased profit margins.

Thus, ICT profiles and their types do affect companies' financial performance, but this relationship varies between different industries.

Conclusion

The study demonstrated the advisability of considering companies' stable ICT profiles in theoretical and practical terms; these profiles are understood as combinations of technologies applied together, which become a source of competitive advantage due to resource complementarity. The resource theory allowed us to obtain two theoretical results:

- conclude that analysing companies' ICT profiles by industry, taking into account the specifics of their ICT architecture and the role of particular technologies in company operations, is a productive approach;
- suggest a classification of ICT profiles by their popularity, complexity, and uniqueness for specific industries; the classification comprises typical, complex, and specific profile types.

The methodological result of the study is adapting the association rules method to identify ICT profiles at the industry level, including substantiating the "support" and "credibility" levels.

The key empirical results include the following. Analysis of the diversity and complexity of ICT profiles revealed significant heterogeneity of the domestic corporate landscape in terms of the use of stable ICT combinations in various industries. This confirms the need to take into account industry specifics when designing state programmes to promote digital transformation of the economy. On average, companies use two ICT systems, so typical ICT profile includes BPM and SaaS systems. The use of AI-based solutions by Russian companies has not yet become sufficiently widespread, which allows us to highlight this vector as a promising business digitalisation path. Analysis of the success of adopting various ICT profiles in terms of increasing company productivity and profit margins did not yield clear results.

The theoretical and empirical conclusions of the paper can help increase digital maturity and the quality of Russian companies' digital transformation, which matches the objectives of the national programme "Digital Economy of the Russian Federation". Our full-scale study of domestic companies' ICT profiles based on data on more than 29 thousand firms operating in 31 industries allowed to identify three stakeholder groups. The first comprises ICT suppliers who will be able to identify potential market niches and opportunities for promoting multi-tech products. The second target group is industry players themselves, who will be able to compare their ICT profile with the one typical for their industry, evaluate their competitive environment, consider alternative technology combinations, most relevant offers on the ICT solutions market, and possible ways to optimise the use of ICT based on benchmarks. This, in its turn, should help promote demand for ICT products and technologies. The third target group is the academic community specialising in studying technology management and corporate economics. Of greatest interest to this group are empirically tested stable ICT combinations which reflect industry specifics, and the correlation of their use with companies' financial results.

The limitations of the study include the reluctance of many Russian companies to disclose information about their implementation of ICT systems. The paper is based on open data posted on the internet, which does not exclude the possibility that in reality ICT systems, including AI-based ones, are used more broadly. The prospects of further research include studying the dynamics of ICT profiles, and identifying the reasons for the financial failure of some of them in certain industries. Annual monitoring of Russian companies' ICT profiles can be of a practical use for investors and financial institutions as an analytical tool. Companies could conduct such monitoring to plan long-term growth, which would help achieve sustainability and transparency.

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Appendix 1. **Technologies included in ICT profiles of Russian companies**

Technology	Description
BPM	Business Process Management: improving organisations' performance and quality of work of by optimising business processes.
SaaS	Software as a Service: storing applications on remote servers with access via a web browser, eliminating the need to install them on user devices.
CRM	Customer Relationship Management: technologies for attracting and retaining clients, and improving customer relationships.
EDM	Electronic Document Management: creating, processing, storing and transmitting electronic documents in the organisation.
HRM	Human Resource Management: planning, hiring, training, performance management, employment termination.
WMS	Warehouse Management System: receiving, storing, and shipping goods.
LIS	Laboratory Information System: collection, processing and analysis of medical data.
TMS	Transportation Management System: route planning, cargo tracking, and vehicle management.
MES	Manufacturing Enterprise Solutions: planning, process monitoring, and product quality control.
PDM	Product Data Management: managing all product-related information.
PLM	Product Life Cycle Management: from concept to launch.
DC	Data Centres: processing data using servers and other computing equipment.
ITSM	IT Service Management: designing, creating, delivering, operating. and managing information technology services provided to clients.
SRS	Storage and Retrieval System: digitisation of electronic documents.
BI	Business Intelligence: collection, analysis, and transformation of data into information to help companies make better business decisions.
CPM	Corporate Performance Management: planning, budgeting, forecasting, and analysing financial and operational data to achieve the company's strategic goals.
FMS	Flexible Manufacturing System: managing equipment, materials, personnel, and production processes to optimise company operations.
IS	Information Security: protecting information from unauthorised access, leaks, damage, or destruction.
Cloud Computing	On-demand access to computing resources via the internet, such as servers, data storage, and applications, charging only for the use.
OSS/BSS	Operation Support System/Business Support System: integrated management of corporate telecommunication resources.
PaaS	Platform as a Service: providing access to internet platforms to users for developing, testing, and deploying applications without the need to manage infrastructure.
IaaS	Infrastructure as a Service: providing virtual computing resources over the internet, i.e. renting infrastructure such as virtual machines, data storage, and network resources as an alternative to purchasing and maintaining their own.
CMS	Content Management System: tools for creating, editing, and managing website content and access rights.
OLAP	Online Analytical Processing: collecting, processing, and analysing large volumes of data from various sources to support companies' strategic decision-making.
SCM	Supply Chain Management: managing the flow of goods and services from suppliers to end users, including inventory management, demand forecasting, order management, and logistics.
SRM	Supplier Relationship Management: solutions for strategic selection of suppliers, new product types from a number of possible alternatives, and implementing the entire procurement cycle, including electronic trading platforms.
PACS	Physical Access Control System: controlling access to buildings, premises, or information systems, including identification, authentication, and authorisation systems.
ERP	Enterprise Resource Planning: business process management system which allows companies to automate and improve management of personnel and resources, including finance, production, sales, and procurement.
VC	Video Conferencing systems, which allow users share video, audio, and text-based information in real time while being in different places.
VSS	Video Storage Systems: specialised applications for managing cameras, recording and playing back videos, analysing data, and warning about possible threats. Can be installed on system operators' computers or on special record storage and processing servers.
SCN	Satellite Communications and Navigation: communications between satellites and the Earth, establishing objects' location on the surface of the planet; navigation applications which use satellite systems' data to determine objects' precise coordinates.
PMS	Property Management System: managing time, budget, resources, objectives, and communication in the scope of a project.
VST	Vehicle Safety Technology: monitoring and managing vehicle safety by tracking their location, speed, driving direction, fuel consumption, engine state, and other parameters.
ATS	Automated Trading System: servers for managing cash registers; sales floor management systems; trading enterprise management systems; additional modules for trade management systems such as decision support, product layout automation, etc.
RBS	Remote Banking Service: providing access to bank accounts and services to clients via the internet.