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The influence of the breadth of the tech stack on the result of the digital product: A view through the theory of absorption capacity

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Abstract

In today's economy based on knowledge and innovation, the development of absorptive capacity by companies is a critical aspect of business competitiveness. In this study, the tech stack of sites is considered as a specific, measurable part of the digital and innovative development of a company. In literature to date, there is no clear answer to which technologies and in what quantity should be included in the tech stack.

From the point of view of assessing the tech stack, mainly qualitative methods are proposed that are quite resource intensive. Accordingly, the purpose of this study is to determine the impact of the technologies used by the characteristics of quantity, uniqueness and popularity in the tech stack of the product on the result (the absence of critical errors); as well as in developing a quantitative approach for assessing the impact of the technologies used on the result of a digital product. The quantitative approach was developed and conceptualized based on previous literature, tested on 12 sites of large Russian banks, including 12 main domains and 595 subdomains. An analysis of a study of 216 online applications for banking products showed a positive relationship between the share of unique technologies in the bank's visible tech stack and the number of errors, as well as a negative relationship between the share of popular technologies in the stack and errors. This study expands the discussion on the development of absorptive capacity, contributes to the understanding of the limitations of absorptive capacity of companies and proposes a quantitative approach for auditing the operational tech stack of companies' websites.

Keywords: tech stack, innovation, absorption capacity, digital marketing, website

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Introduction

Business in the modern world is highly dependent on knowledge and innovative development. Many researchers note a company's ability to innovate and make current changes as one of the main factors of competitiveness and prospects for its development (for example: [1, 2]). However, knowledge leading to current business transformations is mainly generated outside a specific company, in uncontrolled dynamic systems that include a large number of actors [3], which raises issues related to the identification, assimilation and use of external knowledge.

In 1990, Cohen and Levinthal [4] proposed the concept of absorptive capacity of organizations, which includes the ability to recognize the value of new information, assimilate it and apply it for business purposes. Over the past decades, this concept has received serious development: a number of researchers have focused on the development of conceptualization and operationalization of this concept [5, 6]; other researchers have turned to the study of internal company factors and external environmental factors affecting the absorptive capacity of companies [3, 7–9]. Another significant direction in the development of this concept was the study of the effects on the company from the development of absorptive capacity.

The knowledge obtained in the framework of the latest direction of research is currently quite fragmentary, sometimes contradictory. So, despite the fact that a number of studies confirm a positive relationship between the introduction of innovations in a company and the results demonstrated [10–14], there are also studies that indicate that the relationship may also be negative: the desire for innovation can lead to more risky, complex and less linear processes [15] and (potentially) more asymmetrical returns [16]. Other scholars argue that firms with high innovative activity suffer from low collateral assets and long and uncertain payback periods [17, 18].

In 2022, Lehmann, Menter and Wirsching found that the relationship between firm productivity and absorptive capacity has an inverted U-shape [9], indicating that companies have a certain optimum point, but after that is crossed an increase in knowledge absorption, an increase in investment in R&D is not practical. However, no convincing proposals have yet been presented as to how to determine this very optimum point; how to identify useful and useless innovations; how to evaluate your own company from the point of view of sufficient innovation saturation and avoid negative influence.

This study examines the tech stack of banking websites as a specific, measurable part of a company's digital and innovative development. Today it is impossible to imagine an organization without an online presence in the form of a website, landing pages for promoting specific products or services, and online forms for filling out applications. The more a company interacts with its customers in digital channels, the more attention it pays to online technologies and the tech stack.

With the growing diversification of available technologies, the expansion of functionality, the increase in the number of suppliers of such tools, as well as changes in legislation, for example, on privacy protection [19], the tech stack has become an extremely promising object of analysis in terms of its optimization and the use of certain technologies.

By including a large number of technological tools in their own stack (increasing its breadth), banks, on the one hand, demonstrate a high level of development of absorptive capacity; on the other hand, they increase the risks of their joint "unassimilation," which can lead to technical errors and failures in the operation of the digital product. Researchers believe that auditing the current tech stack not only allows you to get rid of unnecessary technologies, but also contributes to the development of a more informed approach to choosing technologies in the future [20, 21].

However, to study and audit the tech stack, researchers and practitioners mainly propose a qualitative approach, which involves analyzing each technology separately for the need for its use [20]. Despite the fact that this approach has certain advantages, it nevertheless requires serious human and time resources.

In accordance with the identified gaps, the purpose of this study is to determine the impact of the technologies used by the characteristics of quantity, uniqueness and popularity in the product tech stack on the result; in developing a quantitative approach to assessing the impact of the technologies used on the quality of the product.

The following research questions were formulated:

1. How does increasing the breadth of the tech stack (inclusion of a large number of technologies) affect the quality of the product (number of errors)?
2. How does the use of unique technologies affect the quality of the product (the number of errors)?
3. How does the use of popular technologies affect the quality of the product (the number of errors)?

This study presents and tests a quantitative approach to assessing the performance of a product such as a company website (main domain and all subdomains) based on an analysis of the tech stack. A positive relationship was found between the share of unique technologies and the number of errors, as well as a negative relationship between the share of popular technologies and the number of errors.

This study contributes to the development of absorptive capacity theory, in particular in the direction of studying the results of the company obtained from the development of absorptive capacity expressed in the use of a wide range of external products, and also offers a concrete practical tool for assessing the effectiveness of adding a large number of products to its own tech stack from unique technologies and popular technologies.

1. Absorptive capacity

In the seminal work of Cohen and Levinthal (1990), absorptive capacity is defined as "the ability to recognize the value of new information, assimilate it and apply it to commercial purposes" [4]. One of the most important assumptions of this concept is that the ability to find and use external knowledge contributes to the development of the innovative potential of companies, which is especially important in a knowledge-based economy [3]. Cohen and Levinthal (1990) called absorptive capacity generators a company's investments in R&D, the company's production activities and investments directly in absorptive capacity (for example, through personnel training) [4].

Further development of this concept was taken up by many researchers, who also tried to rethink it and create a more precise conceptual framework. In particular, Zahra and George [5] identified four capabilities that collectively represent a company's absorptive capacity: acquisition, assimilation, transformation and exploitation. Moreover, in response to the question of whether all acquired knowledge can be assimilated and used, researchers have proposed dividing absorptive capacity into two subcategories: potential absorptive capacity, which includes the processes of acquiring and assimilating knowledge; realized absorptive capacity, which includes the processes of transformation and exploitation of knowledge [5].

The division of absorptive capacity into potential and realized kinds has become a natural consequence of the problem of knowledge acquired but not used by companies for various reasons [8]. Among the factors that have a direct impact on a company's absorptive capacity are internal factors: previous knowledge base [4, 6, 7, 9], absorptive capacity, employee competencies, company size, investments in R&D [4, 6], organizational structures [6, 7] and others; external: knowledge environment, company position in knowledge networks [6].

Also, one of the most important questions about the use of external knowledge by companies is whether the innovative potential of companies will grow indefinitely with the constant acquisition of new knowledge. In 2022, Lehmann, Menter and Wirsching found that the relationship between firm productivity and absorptive capacity has an inverted U-shape [9], indicating that companies have a certain optimum point, and after they cross that an increase in knowledge absorption, an increase in investment in R&D is not practical. However, methods for estimating the optimum, as well as the reasons for the decrease in efficiency after crossing it, remain insufficiently studied.

Thus, the assumption that not all acquired knowledge can be absorbed and implemented by companies, as well as the assumption that "more is not better," are key prerequisites for conducting this study and developing a quantitative approach to assessing product performance depending on the number of built-in innovation.

2. Tech stack

A tech stack is a set of technologies on the basis of which digital applications and websites are developed. Various digital tools, databases, programming languages, etc. can be integrated into the tech stack [22]. With the growing diversification of available technologies, the expansion of functionality, the increase in the number of suppliers of such tools, as well as changes in legislation, for example, on privacy protection [19], the tech stack has become an extremely promising object of analysis in terms of its optimization and the use of certain technologies.

The motivation for increasing the complexity of one's own tech stack and integrating a large number of digital solutions into it, in addition to functional benefits, is also the growing demand of customers who expect to see increasingly automated and high-tech solutions to their problems. At the same time, a well-designed tech stack can be a source of competitive advantage [21].

All this encourages companies to constantly study the emergence of new technologies and determine priorities for investing in the company's tech stack [23]. In addition to searching for new technologies, modern researchers emphasize the need to conduct regular audits of their tech stacks for redundancy. Moreover, researchers also believe that an audit of the current tech stack allows you not only to get rid of unnecessary technologies, but also contributes to the development of a more informed approach to the choice of technologies in the future [20, 21]. This also corresponds to the provisions of the development of absorptive capacity and the need to have prior knowledge for the correct assimilation of new ones. In addition, the capabilities of a tech stack significantly depend on the team that is involved in its development and optimization [21].

One of the most important problems that can arise from the incorrect use of technology or the use of untested technologies for digital products is the emergence of "critical" errors that prevent the achievement of key product goals.

For example, the main indicator of the effectiveness of a landing page is the conversion from a visitor to those who completed an application [24], and the interaction of consumers with the company's website as a whole is an important part of the company's relationship with its audience [25]. A landing page is a complex product that can have an arbitrarily complex front-end structure (everything that the browser can read, display and/or run) and a back-end, and behave differently depending on the environment in which it is tested, such as different phone operating system models, different brands, and different browser versions. All this, on the one hand, actualizes the desire of companies to introduce more and more new innovations into their own tech stack, but, on the other hand, it leads to an increase in the risks of "critical errors."

In this study, the result of the landing page tech stack is assessed precisely by identifying the presence or absence of "critical" errors, that is, those that do not allow users to complete the filling out of the questionnaire (for example, SMS does not arrive to confirm data, or the "next" button is not pressed to fill out a form, or after going to the State Services portal and obtaining consent to use the data, this data is not saved and must be re-entered manually, etc.). Based on the above, we formulate the first research question:

– How does increasing the number of technologies in the tech stack affect the results of products (the number of errors)?

The use of newly emerging or simply rare technologies for the market requires time, human resources and specialization, and, ultimately, R&D costs to absorb and assimilate them. According to this study, we seek to determine whether there is a relationship between the number of unique technologies (which no one except this company or firm uses) and the number of errors; is there a negative relationship between the share of popular technologies (which are used by more than half of the agents under study) and the number of errors. Accordingly, two other research questions:

– How does the use of unique technologies affect the results of products (the number of errors)?

– How does the use of popular technologies affect the results of products (the number of errors)?

To study the tech stack, researchers and practitioners mainly offer a qualitative approach which is associated with the analysis of each technology separately for the need for its use [20]. Despite the fact that this approach has certain advantages over quantitative research, it nevertheless requires serious human and time resources.

This study proposes an original quantitative approach to conducting an audit of a website's tech stack, allowing one to assess the state of one's own tech stack in comparison with similar companies, as well as identify technologies that could potentially influence the increase in the number of errors.

3. Quantitative approach

In order to assess the number of technologies used in the tech stack of banking websites, we chose the well-known BuiltWith service, which collects and classifies the majority of known technologies on all registered domains since 2002, based on signals from the websites themselves about the use of a particular technology.

The choice of industry for the study was based on review in the most developed companies in terms of technology implementation. Banks were chosen as research objects, since the Russian financial sector is one of the leaders in digital transformation. "According to calculations by ISIEZ HSE University according to Rosstat, the digitalization index of the domestic financial sector at the end of 2019 reached a value of 34 and was second only to industry (with an indicator of 36)” [26, p. 159], while “the internal costs of financial sector organizations for the creation, distribution and use of digital technologies and related products and services amounted to 380.2 billion rubles, which corresponds to 8.9% of the gross added value of the sector, leaving all other sectors of the economy and social sphere far behind in these most important indicators” [26, pp. 159–160]. According to the results of the FINIX study by Yakov and Partners (the former Russian division of McKinsey) in March 2023, “large Russian banks successfully survived the shocks of 2022 and maintained global leadership in terms of digitalization” [27]. Banks are therefore a particularly interesting sector from a tech stack research perspective.

Banks were selected for the study based on asset indicators [28], after which requests were sent to check the technologies used with the help of the above-mentioned Built With service. Some banks did not provide permission to the service robots to record technology; therefore, only those banks for which data was available were included in the final list.

The collected lists of technologies found on the main sites and subdomains were transferred to Excel spreadsheets and analyzed. The number of technologies was calculated for each of the standard rubricators of the service, then the total number of technologies used by the bank was calculated, as well as the number of non-repeating technologies in the stack of each bank, the share of unique technologies in the stack (the number of technologies, that is, used by only one bank from the list to the number of non-repeating technologies used by this bank), “rare” technologies in the stack (the number of technologies used by only 1–2 banks from the list to the number of non-repeating technologies used by this bank), “popular” technologies in the stack (the number of technologies used by the majority, that is, more than 6 banks from list to the number of non-repetitive technologies used by this bank) [29].

To assess the performance of the sites, the process of filling out online applications for banking products to obtain bank approval was studied. The screen of a mobile phone or computer was recorded. Next, for the purposes of our study, we counted the cases of critical errors occurring when filling out the questionnaire (which should not have occurred). We called critical errors when the user could not continue filling out the form (for example, the SMS does not arrive to confirm the data, or the “next” button is not pressed to fill out the form, or after going to the State Services portal and obtaining consent to use the data, this data is not saved and they must be entered again manually, etc.). In 2021–2022, materials were publicly published based on this study, which took into account the number of errors recorded by researchers. Most of the banks studied had signed agreements providing for a detailed review of the application process and review of errors. There has not been a single precedent when a bank challenged a factual error recorded and recorded on the screen of a smartphone or computer. Links to public materials are provided in Appendix.

A non-parametric Spearman test was then applied to look for a correlation between the above tech stack metrics and the percentage of errors encountered when filling out online questionnaires.

4. Results

At the time of the study on June 1, 2022, 12 domains and 595 subdomains of the studied banks were available for verification (*Table 1*).

After grouping by technology type in accordance with the classifier proposed by the BuiltWith service, 529 non-repeating technologies were discovered, collected in 25 groups, which were used by banks 2189 times (*Table 2*). The leaders in terms of the number of uses by banks include the following technologies: JavaScript Libraries and Functions (622 times); Analytics and Tracking (209 times); Frameworks (190 times). The technologies are used the greatest number of times in Tinkoff, Alfa-Bank, Otkritie Bank, the least in Rosbank, SMP Bank and Gazprombank.

Table 1.

Researched banks, domains and subdomains

Bank name	Domain name	Number of subdomains examined
Alfa-Bank	ALFABANK.RU	100
BSPB	BSPB.RU	25
Gazprombank	GAZPROMBANK.RU	25
MKB	MKB.RU	64
MTS Bank	MTSBANK.RU	102
Otkritie Bank	OPEN.RU	52
Raiffeisenbank	RAIFFEISEN.RU	57
Rosbank	ROSBANK.RU	36
Rosselkhozbank	RSHB.RU	38
SMP Bank	SMPBANK.RU	29
Sovcombank	SOVCOMBANK.RU	30
Tinkoff Bank	TINKOFF.RU	37
Total	**12**	**595**

Table 3 for each bank calculates the total number of unique (used in only one bank), rare (used in two banks or less) and popular (used by more than six banks) technologies.

The largest number of unique technologies was discovered in Alfa-Bank (54 technologies), which is 22.6%, and Tinkoff, which is 30.4%.

The number of detected and recorded errors when filling out online applications for banking products was 25 out of 216 surveyed questionnaires (12%). The frequency of errors per questionnaire for each bank is shown in *Table 4*.

To detect the relationship between tech stack indicators and errors, the following indicators were calculated by bank:

a) the total number of technologies used;

b) the number of non-repetitive technologies;

c) the share of unique technologies in the bank's stack (unique – that is, used only by this bank from the list of studied banks);

d) the share of "rare" technologies (that is, used in 1–2 of the banks studied);

e) the share of "popular" technologies (that is, used in more than half of the banks studied).

Table 2.

Identified technologies divided into groups within the Builtwith service

Technologies \ Banks and their main web domains	Alfa-Bank ALFABANK.RU	BSPB B SPB.RU	Gazprombank GAZPROMBANK.RU	MKBank MKB.RU	MTS Bank MTSBANK.RU	Otkritie Bank OPEN.RU	Raiffeisenbank RAIFFEISEN.RU	Rosbank ROSBANK.RU	Rosselkhozbank RSHB.RU	SMP Bank SMPBANK.RU	Sovcombank SOVCOMBANK.RU	Tinkoff Bank TINKOFF.RU	Total
Advertising	23	6	5	6	7	8	3	5	3	4	6	9	**85**
Analytics and Tracking	28	15	10	10	18	27	16	17	11	7	17	33	**209**
Audio / Video Media	2		1	1	2	5	4	1			4		**20**
Content Delivery Network	14	6	1	4	5	10	8	2	8		3	3	**64**
Content Management System	10	2	2		9	3	2		2	3		4	**37**
Copyright	2	3	1	3	1	3	3	1		1			**18**
e-Commerce	1			1					1			1	**4**
Email Hosting Providers	6	2	4	2	5	4	4	2	2	2	4	9	**46**
Frameworks	36	10	3	45	18	14	6	6	6	5	18	23	**190**
JavaScript Libraries and Functions	81	49	37	81	48	66	55	22	39	37	45	62	**622**
Language	1	1	1	1	1	4	1	1	1	1	3	1	**17**
Mapping	1	1	2	1	1		2		1			1	**10**
Mobile	30	9	8	14	11	13	27	6	8	10	7	9	**152**
Name Server			2			1				1		4	**8**
Operating Systems and Servers	6	4	2		2	2	2	1	1	1	3	2	**26**
Payment	7	4	4	8	6	7	3	6	4	2	6	13	**70**
Robots.txt	8	4	1	1	2	7	1	3	2	2	6	14	**51**
SSL Certificates	25	8	8	18	18	30	20	4	6	3	6	32	**178**
Syndication Techniques	3					1						2	**6**
Verified CDN	1					1							**2**
Verified Link									3		1	1	**5**

Banks and their main web domains / Technologies	Alfa-Bank ALFABANK.RU	BSPB B SPB.RU	Gazprombank GAZPROMBANK.RU	MKBank MKB.RU	MTS Bank MTSBANK.RU	Otkritie Bank OPEN.RU	Raiffeisenbank RAIFFEISEN.RU	Rosbank ROSBANK.RU	Rosselkhozbank RSHB.RU	SMP Bank SMPBANK.RU	Sovcombank SOVCOMBANK.RU	Tinkoff Bank TINKOFF.RU	Total
Web Hosting Providers	9	4	3	1	6	4	4				1	50	**82**
Web Master Registration	1	2		3	1	2	4	1	2		2	2	**20**
Web Servers	13	16	8	1	15	19	9	1	4	8	6	18	**118**
Widgets	20	21	5	14	11	17	8	10	6	3	14	20	**149**
Number of technologies used	328	167	108	215	187	248	182	89	110	90	152	313	**2189**
Number of non-repeating technologies used	239	134	96	123	140	172	126	85	107	73	136	168	**529**

Table 3.

Analysis of technologies in tech stacks of bank websites

Banks and their main webdomains	Number of unique technologies	Number of rare technologies	Number of popular technologies	Share of unique technologies	Share of rare technologies	Share of popular technologies
Alfa-Bank ALFABANK.RU	54	96	71	22.6%	40.2%	29.7%
BSPB BSPB.RU	22	33	68	16.4%	24.6%	50.7%
Gazprombank GAZPROMBANK.RU	7	18	49	7.3%	18.8%	51.0%
MKBank MKB.RU	20	30	55	16.3%	24.4%	44.7%
MTS Bank MTSBANK.RU	15	32	67	10.7%	22.9%	47.9%
Otkritie Bank OPEN.RU	25	44	68	14.5%	25.6%	39.5%
Raiffeisenbank RAIFFEISEN.RU	12	25	57	9.5%	19.8%	45.2%
Rosbank ROSBANK.RU	4	8	58	4.7%	9.4%	68.2%
Rosselkhozbank RSHB.RU	19	25	54	17.8%	23.4%	50.5%
SMP Bank SMPBANK.RU	6	12	43	8.2%	16.4%	58.9%
Sovcombank SOVCOMBANK.RU	22	34	71	16.2%	25.0%	52.2%
Tinkoff Bank TINKOFF.RU	51	76	61	30.4%	45.2%	36.3%

Table 4.

Frequency of errors detected during the study of online questionnaires of banks

Domain	Number of applications filled	Number of errors	Frequency of errors
ALFABANK.RU	21	1	0.05
BSPB.RU	8	2	0.25
GAZPROMBANK.RU	21	1	0.05
MKB.RU	15	5	0.33
MTSBANK.RU	17	1	0.06
OPEN.RU	21	4	0.19
RAIFFEISEN.RU	21	4	0.19
ROSBANK.RU	21	0	0.00
RSHB.RU	21	5	0.24
SMPBANK.RU	8	1	0.13
SOVCOMBANK.RU	21	0	0.00
TINKOFF.RU	21	1	0.05
Total	**216**	**25**	**12%**

The results obtained are shown graphically in *Fig. 1.*

Based on the data presented in *Fig. 1*, we can conclude that the population of banks is heterogeneous in terms of rare or unique technologies; two banks with a higher number of unique technologies stand out significantly (see *Table 4*): this is Alfa-Bank (54 unique technologies) and the bank Tinkoff (51). They also stand out in terms of "rare technologies" – there are 96 of them at Alfa-Bank and 76 at Tinkoff Bank. The shares of "rare" (40% and 45%, respectively) and unique technologies (23% and 30%) are maximum for the stacks of each of these banks in comparison with the rest of the ones studied. At the same time, the share of technologies used by most banks in the stack of these banks is minimal for the sample (30% and 36%). That is, both banks stand out noticeably from the general population in terms of stack indicators.

At the next stage of analysis, to identify the relationship, the nonparametric Spearman rank correlation test was calculated, which turned out to be insignificant for all selected groups within the entire population of banks ($n = 12$). However, after separating the two specified banks – Tinkoff and Alfa Bank – from the population (in terms of the number or share of unique technologies in the stack), for the rest of the banks ($n = 10$) a significant inverse correlation (p less than

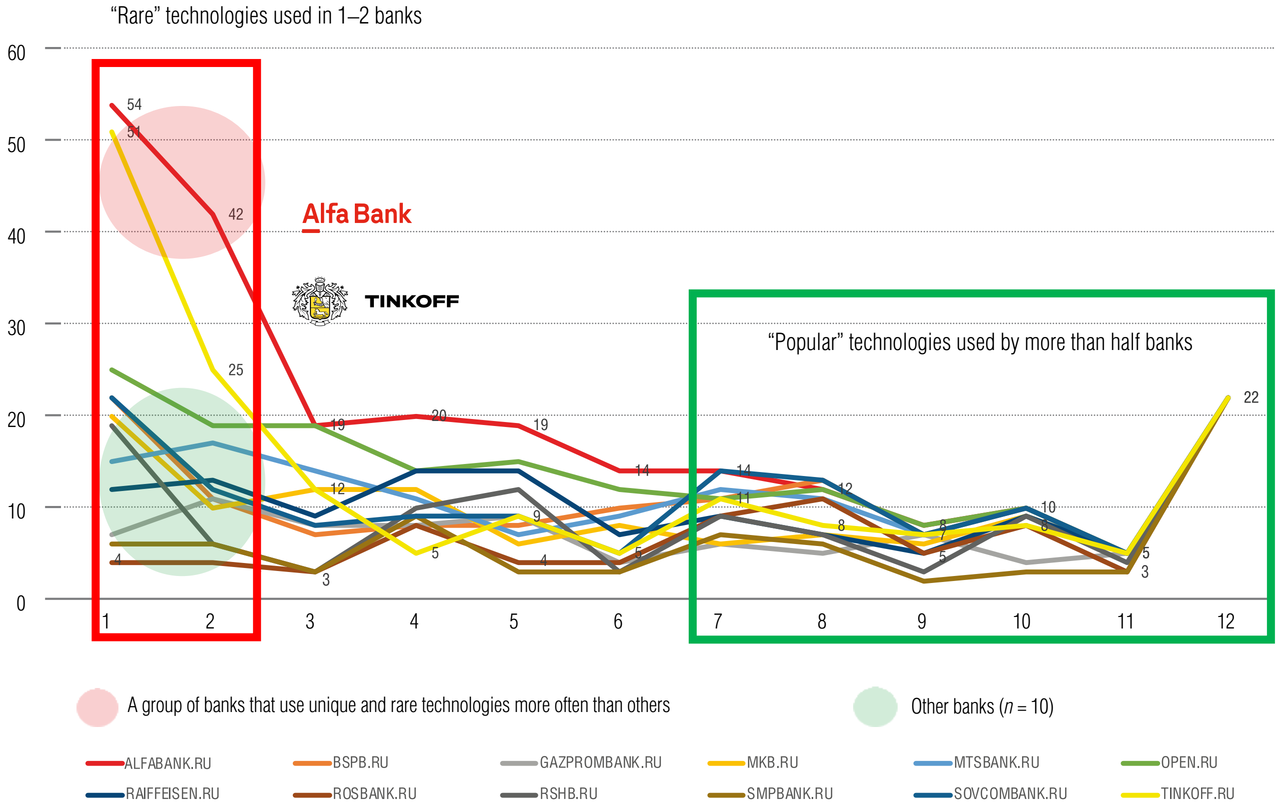

Fig. 1. Distribution of unique technologies by frequency of occurrence in the banks studied ($n = 12$):
x-axis – how many banks use the same technology,
y-axis – the number of such technologies in the bank.

0.05) was found between the proportion of errors in the questionnaires and the share of popular technologies in the bank's stack, and the same significant correlation between the share of errors and the share of unique technologies in the bank's stack (*Table 5*).

According to the results obtained, no statistically significant correlation was found between the increase in the number of technologies in the tech stack and the result of the product (number of errors). A similar result was obtained after removing two outlier banks ($n = 10$), and although the Spearman indicator increased, the correlation did not reach the significance level of 0.05.

The indicator of the share of unique technologies in the tech stack also did not show a significant correlation with the result of product performance (number of errors) for all banks ($n = 12$) but showed a significant correlation ($p < 0.05$) after removing two outstanding banks from the sample ($n = 10$). That is, the greater the share of unique technologies in the stack, the more likely it is that errors will appear on the landing page.

The share of popular technologies in the stack has an inverse correlation with the number of errors ($p < 0.05$) for the sample after excluding Alfa-Bank and Tinkoff Bank ($n = 10$) and may be a good indicator. In contrast to the uniqueness of the stack, we see that for most of the banks studied, the use of popular technologies is inversely related to the indicator of the quality of the site (the number of errors), and at the same time

Table 5.

Indicators of technology distribution by studied domains and subdomains of banks, surveyed questionnaires, detected errors and correlations by group

Domain	Number of technologies used	Number of non-repeating technologies used	Share of rare technologies (2–)	Share of unique technologies (<2)	Share of popular technologies (7+)	Number of applications studied	Errors detected	Errors as a share of questionnaires
ALFABANK.RU	328	239	40%	23%	30%	21	**1**	0.05
BSPB.RU	167	134	25%	16%	51%	8	**2**	0.25
GAZPROMBANK.RU	108	96	19%	7%	51%	21	**1**	0.05
MKB.RU	215	123	24%	16%	45%	15	**5**	0.33
MTSBANK.RU	187	140	23%	11%	48%	17	**1**	0.06
OPEN.RU	248	172	26%	15%	40%	21	**4**	0.19
RAIFFEISEN.RU	182	126	20%	10%	45%	21	**4**	0.19
ROSBANK.RU	89	85	9%	5%	68%	21	**0**	0.00
RSHB.RU	110	107	23%	18%	50%	21	**5**	0.24
SMPBANK.RU	90	73	16%	8%	59%	8	**1**	0.13
SOVCOMBANK.RU	152	136	25%	16%	52%	21	**0**	0.00
TINKOFF.RU	313	168	45%	30%	36%	21	**1**	0.05
Spearman correlation (n = 12)	0.14	–0.10	0.01	0.23	–0.22	216	25	12%
Spearman correlation, without Alfa Bank and Tinkoff Bank (n = 10)	0.51	0.11	0.37	0.69	–0.63			
Significance (n = 10)				$p < 0,05$	$p < 0,05$			

can bring obvious benefits for the development and support of complex digital products without the use of rare technologies and rare specialists, obtaining possible savings in payroll and reducing the diversity of supported competencies in product development and testing.

5. Discussion

This study attempts to assess the impact of technologies included in the tech stack of banking websites on the performance of a given digital product, as an example of the impact of absorptive capacity.

Having studied the tech stack of sites for the number of technologies used in the tech stack and for the number of errors, a connection between them was not found, which is most likely due to the complex nature of technological development and the unique approaches of each individual bank to the selection and integration of technologies, which is consistent with previous studies, indicating that the success of innovation absorption depends on factors such as the previous knowledge base [4, 6, 7, 9], absorptive capacity, employee competencies, company size, R&D investments [7, 14], organizational structures [4, 6], etc.

However, a moderate positive relationship was found between the share of unique technologies and the number of errors for ten banks, after excluding two outliers from the analysis. That is, the greater the share of unique technologies in the stack, the more likely it is that errors will appear on the landing page. In interpreting the result obtained, we draw attention to the fact that "stand-out banks" are an example of banks that have relied on the uniqueness of the stack they use (judging by the indicators of a high share of unique and rare technologies and a low share of "popular" technologies). Also, these banks are leaders in the main technology ratings in the Russian market, such as MarksWebb [30], Banking Review [31], FrankRG [32], these banks have proven themselves in working with their unique stack and demonstrate good business results. For banks that have not yet defined their unique stack, it is probably worth paying attention to the use of a quantitative approach to assessing the tech stack, as a prognostic indicator that allows you to quickly assess the degree of uniqueness of the technologies used and possibly take measures to qualitatively reduce the unjustified diversity of technologies to reduce the number of errors. Additional benefits from reducing the number of unique technologies may include an advantage in the selection and recruitment of personnel (there is no need to search and test rare specialists), launch speed (reducing the stages of familiarization with the technology and maintaining competencies in the use of technologies unique to the market), and the absence of an "overpayment for the uniqueness" of a specialist, reducing the risk of finding a replacement for a unique specialist, the unpredictability of the behavior of new exotic technologies, etc.

A moderate negative relationship was also found between the share of popular technologies and the number of errors for ten banks, after excluding two outliers from the analysis. In addition to the finding that the number of unique technologies leads to an increase in the number of errors, it was found that for the majority of banks studied, the use of popular technologies is inversely correlated with the indicator of the quality of website performance (number of errors), and at the same time can provide obvious benefits in terms of developing and maintaining complex software products without the use of rare technologies and rare specialists, obtaining possible savings in the wage fund and reducing the variety of supported competencies in product development and testing.

The results obtained during the study confirm the current discussion about the need to audit companies' tech stacks [20, 21]. Using the proposed quantitative approach will allow companies to determine the degree of uniqueness and popularity of a tech stack in their competitive environment and assume comparative indicators of the risk of errors and formulate a qualitative plan for further optimization of the tech stack to retain only effective technologies that correspond to the level of competencies of the company's specialists.

Conclusion

In summary, this study continues and expands the debate on the development of absorptive capacity, contributes to the understanding of the limitations of absorptive capacity of companies and offers a quantitative approach to audit the tech stack of company websites.

Based on the results obtained, it can be assumed that the proposed quantitative approach will primarily be applicable to those companies that have not yet identified their unique tech stack. The use of unique technologies can contribute to a greater number of errors, including in those companies that do not have sufficient resources, such as team competencies and prior knowledge. In turn, the use of popular technologies, on the contrary, will contribute to fewer errors.

Significant directions for future research include retesting the developed quantitative approach on a large sample, as well as qualitative study of unique and popular technologies. Moreover, based on the mixed results obtained in relation to two prominent banks, digital leaders, a promising direction is to develop a factor model that characterizes the key factors that influence the assimilation and correct use of various technologies in their own digital products. A promising direction for further research is also the development of combined approaches to auditing the tech stack, including both quantitative and qualitative research. The development of such an approach should focus on maximizing the strengths of each of the combined approaches and minimizing the weaknesses.

Of course, this study has a few limitations. Thus, only the banking industry was considered; in the future, the proposed quantitative approach can be tested in many industries and a comparative assessment can be made. Another limitation is the small sample, primarily due to limited access to technology stack analysis by many banks. As another limitation, the approach of dividing technologies only according to indicators of uniqueness, rarity and popularity can be highlighted; however, in the future, other classifiers can be used for evaluation. ■

Appendix.

Materials have been published that take into account the number of errors recorded by researchers

https://bosfera.ru/bo/dorabotat-mir-2

https://bosfera.ru/bo/na-potreby-publike-god-spustya

https://bosfera.ru/bo/rabota-nad-kreditkami

https://bosfera.ru/bo/vklad-v-druzhelyubie

https://bosfera.ru/bo/dorabotat-mir

https://bosfera.ru/bo/vybiraem-mir

https://bosfera.ru/bo/na-potreby-publike

https://bosfera.ru/bo/kreditnaya-karta-onlayn-trudnosti-i-luchshie-praktiki-bankov

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