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Andrzej Buszko[*]
Anna Firkowska[*]

START-UP MANAGEMENT STRATEGIES AND THE IDEA OF THEIR FINANCING. SEARCHING A PARADIGM

Abstract

Start-ups, which are key to promoting innovation in a globalised economy, have a high risk of failure, often linked with inadequate funding. The article attempts to search for a paradigm combining start-up management strategies with concepts of their financing. An inductive method of scientific reasoning was used. The main objective is to characterize the management strategy depending on the adopted sources of financing, and the auxiliary objective is to determine the specificity of these sources in the context of the adopted strategy. Research questions were asked about the adequacy of the strategy in relation to the sources of financing and the emerging risks.

Based on the analysis, it was concluded that the selection of the source of financing should be closely related to the adopted strategic goal. Unicorn start-ups, with aggressive growth strategies, are more dependent on external sources of funding than on equity. This is associated with a possible loss of management control of the start-up, but it allows for its rapid development. On the other hand, start-ups focused on long-term activity, preferring stable strategies, should rely more on debt financing (bank loans, grants) and on self-financing, which allows them to maintain independence, but may limit the pace of growth. Start-ups planning a quick sale can use a variety of financing sources, including debt financing, accepting higher capital costs in exchange for a quick return on investment.

[*]Ph.D. hab. Prof. UPS, Institute of Management, Pomeranian University in Slupsk Poland
[*] MA UPS, Institute of Management, Pomeranian University in Slupsk Poland

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Introduction

In a market oriented economy, start-ups play a special role. These organizations, provide an important path of opportunity to create rapid revenue growth and implement innovative solutions (Sinha, Biswas, 2024). The founders of a start-up, are usually looking for a target business model, frequently based on rationalization. The undoubted success of the development of a new entity is its transformation into a unicorn. Although there are many different definitional approaches, as a rule, this category includes entities that have assets valued at least $1 billion (Audretsch, et.all. 2020). Such a valuation is a confirmation not only of the right choice of product/service but also of the right strategy for managing the new entity, including the right financing path. Creators of new businesses sooner or later have to refer to various sources of financing. As a first step, a start-up is generally created based on the founders' funds (so-called bootstrapping). These are usually insignificant, as the founders try to see their opportunities in an innovative solution and the identification of an attractive market niche (Lindley, 2024). Thus, relatively quickly, start-up managers seek additional funds, and in this context, an important source is commonly known and used: venture -capital, crowd funding, or business angels (De Angelis, 2024). The negotiating position of start-up managers in terms of raising additional funds increases with the positive market verification of the employed strategy (Jensen, 2024). Even the most innovative solution without proper selection significantly limits further business activity(de Oliveria Mota, et.al 2024). Admittedly, not only business angels, but also others investors may be involved in various forms of investment and they can financially support a start-up, even in its initial version, but this is associated with a higher level of risk (Erikson, 2024). A start-up pursues a distinctive financing strategy. Investments in fixed assets might come later in the operation, and supposed also be headed by continuous liquidity (Breschi, Lassébie, Menon, 2018) . Particular attention is devoted to working capital Edwards, Todtenhaupt, 2020).

Referring to the start-up performance, financing operations with debt may become an extremely dangerous trap. The obligations of a debtor (an entity paying for the cost of borrowed capital), especially in the initial period of operation is a difficult task, and as a result can become a difficult barrier to overcome. A start-up, like any other market entity, is subject to characteristic trends. One can distinguish between the introduction, growth, maturity and decline phases. Each of these phases will require a separate

strategy reflecting in adoption of adequate financing. However, at every stage of a start-up's development, there is the problem of careful strategy and taking care of liquidity. Lack of funds and bottlenecks are closely related to the operation of a start-up and can contribute to its rapid termination. This is confirmed by a large-scale study done by Kartanaitė (2023) , she analyzed the financial condition and strategies of start-ups established after 2000 in Lithuania. A very similar view also appeared in the Polish Startups Report, where authors provided information on the success and failures of new entities. Referring to data posted on Failory, as many as "9 out of 10 newly created star -ups fail, of which 20 % went out of business within one year, and another 50 % did not survive more than 5 years. Among the most frequently reasons for closing their business, start-ups point out: lack of funding, lack of market demand for their product or service and actions of competitors" (Polish Startups 2023). Taking the above data into consideration, it should be concluded that a careful approach is required to adopt not only an appropriate strategy but also funding sources. An important problem arises: aligning the strategy with the possibility of obtaining sufficient capital at the right time and the right time horizon. In the market economy, there are relatively many different sources of financing for start-ups. Despite this, companies of this type fail mainly due to a lack of sufficient funds.

Market economies are subject to continuous globalization processes. At any time, a start-up can face unexpected competition. On the other hand, however, the global market provides for start-ups contact with a larger group of possible shareholders. Most authors focusing on financing strategies emphasize the contradiction of interests between stakeholders and shareholders . The shareholders usually seek profit while stakeholders are interested in the benefits which may be provided by company (Luo, Chen, Wang, 2024). Despite these differences, start-up founders should develop a financing strategy that not only ensures survival, but market success. It is necessary also to pay attention to the on-going discussion among researchers, academics, and managers about the strategy. Some of them believe that the variety of proposals is so great that there is no need to seek other ones solutions (Foss, Klein, 2024). On the other hand, a completely different opinion is supported by a group of researchers headed by Banasl, who believe that practically every new entity should develop its own characteristic strategy that will ensure its market success, primarily based on the relevant paradigms (Bansal, et.al, 2024).

Review of the literature

In every category of science, analysts, researchers, and scientists remarkably often refer to the term of paradigm (Ciesielski, 2014). Although the term is widely used there is no single unified (thus one valid) definition. As a rule, two definitions as well as approaches are proposed. The first

captures a paradigm as a characteristic pattern of behavior, a set of mandatory rules. In the second, a paradigm is treated very generally and refers to universal theories or even a worldview found in a particular branch of science (Brykczynski, 2011). Interesting view in this respect is provided by Popper and Kuhn. Both in their works referred to the issue of paradigm and its role in scientific research. Kuhn defined paradigm as a research method in which there is an accepted pattern of conduct, firmly grounded in theory. Theory in fact is the origin of empirical research (Kuhn, 1963). Popper (2002) based his approach to the category of paradigm as a critique of the positivist approach and the lack of objective verifiability of the phenomenon being analyzed. Any studied phenomenon should refer to a theoretical model - as an important issue to justify the need for empirical research. He introduced the concept of falsification - through which he questioned the verifiability of theories and was too attached to the importance of experiment in research. Jodkowski (1990) emphasizes that the paradigm sets the path of scientific conduct, analysts create a suitable model and thus can effectively conduct scientific research. Brycz and Dudycz (2010) made an perceptive discussion of four types of paradigms in management science. They referred to relativism, positivism, constructivism and critical theory. Authors describe these categories and relate them to the research results achieved. They assume that different paradigms (from both ontological and epistemological perspectives) can justify conclusions to a heterogeneous degree. For example, taking a relativistic approach, the conclusions that are formulated (even on correctly conducted research) do not have to be true at all. The paradigm does not determine what needs supposed to be studied, but sets a certain direction for rational behavior. On the other hand, the research itself should refer to important economic problems and serve not only a certain proposal to improve the phenomena taking place, but also an accurate description of the analyzed case.

In market oriented economies there are more opportunities for the development of start-ups. This manifests itself not only in the reduction of formal barriers (simplification and acceleration of procedures, abolition of bureaucracy, etc.) in the establishment of enterprises (including start-ups), but also in the facilitation of access to financing. Such examples include Israel and Estonia (Eisermann, 2014). Waleczek, Zehren, Flatten (2018), based on their research, published a very interesting report on the financial decisions made by start-up founders. The authors analyzed the behavior of 3017 people who decided to start a business. Involving their own funds was a strategic decision, but in addition to this, they also analyzed the situation in the sector. The share of own capital was strongly correlated with the share of external funds. An interesting proposal for a start-up strategy is the so-called lean start-up strategy. The idea was presented by Ries (2012), who focused on the added value that company offered to the customer. All

those activities that do not offer such value should be treated as redundant. Therefore, the time horizon of the strategy is relatively short, and it is required to establish criteria for evaluation, based on an analytical approach. On the other hand, the problem of strategy in start-ups was also pointed out by Bilton and Cummings (2010), creating the concept of the " creative strategy". They emphasized the role of creativity, innovation and added value. A number of authors pay attention to the purpose of founding a start-up and the industry (Kollmann, 2016). When founders decide to operate in a capital-intensive industry, they need to raise additional funds quickly (Short, et.al 2009). Cassar (2004) made a strategy in a new market entrants dependent on the risks taken. If the risk was relatively high, then the owners sought external financing, which was reflected in the structure of the company's assets. Foreign funds dominated, and own funds accounted for a much smaller share. Mahendra (2023) in his interesting book characterised start-ups operating in the sectors employing artificial intelligence. At its core (regardless of the area of operation), a start-up should base its strategy not only on innovation, but also on delivering value to its shareholders. Consequently, there is an extremely important suggestion to use a value added management strategy. Value management occupies a prominent place among various strategy concepts (value-based management- VBM) and is recognized as an approach that clearly defines a company's goals. Managerial decisions are considered from the perspective of measurable benefits that should occur. Attention is paid not only to the overall level of profit, but to efficiency and the time horizon, as well (Copeland, el.al. 1997).

In the management sciences, and especially in finance, the tools and methodological approaches for evaluating financial decision-making process and company value are highly developed (Klincewicz, 2016). Despite the fact that managers have access to such large databases and theoretical studies, the failures of start-ups are mainly dictated precisely by their failure to achieve adequate financial results. Matzler (2024) and his research team focus on a different strategy in start-up management. Researchers turn their attention to strategic openness. The proposition is embedded in the idea that a company must be open to all kinds of opportunities that arise in market niches. These opportunities are (especially in the continuous process of globalization) frequent, but managers are reluctant to analyze new circumstances and implement them in the business. They prefer employ typical, well recognized strategies (Dobusch, Kapeller, 2018). Therefore the agile management may be considered as the solution. The idea of agile management is also used in start-ups strategies. It focuses on new and unique business ideas (high popularity in project management), and the goal is to achieve the set goals relatively quickly, including financial goals, based on optimization processes (Marques,et.al.2023). An extremely important

aspect in start-up management was pointed out by Stark (2024). The strategy should take into account non only the life cycle of the product, but also the life cycle of the industry and overall situation in the economy. The different phases (introduction, growth, maturity and decline) determine the strategy and access to resources. In the case of a start-up, the greatest needs are during the launch period. At that time, the new born entity should not only have a sufficient amount of own funds, but also access to external funding sources. Taking the above advice into account, a number of authors emphasize the importance of customer relationship management (CRM) strategies. In the traditional approach, the key importance is given to customer relationships, but gradually the idea has been greatly expanded to include both the employees of the company and its customers (Dembinska-Cyran, Holub-Iwan, Perenc, 2004). Having a significant number of partners, contacts make it much easier for a start-up to overcome difficulties, especially at the initial stage of operations. The use of knowledge management should be considered accurate. New innovative solutions should be regarded as the success key in start-up performance. Consequently, the processes of knowledge spread and its practical use can contribute to achieving competitive advantage (Wihayanti, Lubis, Rahmad, 2024).

Intangible assets, especially knowledge, are becoming much more important than typical tangible assets. Tangible assets (including especially financial resources) should be employed as the effect, but not as the business goal (Ayinaddis, 2024). Therefore, the competitive advantage of a start-up ought to be primarily embedded in knowledge resources, and the final success, e.g. the transformation of the entity into a unicorn evidence of the choice of an appropriate strategy of action, including securing in the appropriate level of financial resources.

Methodological assumptions

The research subject is the start-ups strategies. Two research goals were adopted. The main goal is to characterize the strategy of a start-up depending on the source of financing. The supportive goal is to specificity the funding sources in the context of the start up's strategy. The following research questions were employed:

- Should a start-up's management strategy be adjusted depending on its funding sources?
- What are the risks of a flawed source of funding in the context of the start-up's adopted goal?

The inductive method of scientific thinking was used.

Start-up management vs. funding sources

Start-up founders usually choose one of three basic goals. The first is based on the premise of turning the new organization into a unicorn . The achievement of this goal is a confirmation of the choice of the right management and financing strategy. It is also a measurable proof of achieving business success. Regardless of the country, not all start-ups become unicorns (Honjo, 2000).

Owners of a start-up can also adopt another rational goal. It is to own business operations. Then the entity has a long-term perspective of operation, and the strategies are intended to provide a safe, stable option for operating in the market. A popular goal of a start-up is to sell it. The founders, when committing their resources, count on their quick return, resulting from an attractive sale. Therefore, they employ aggressive strategies, ensuring the achievement of satisfactory results in the short term, especially financial result. Managers also have a dilemma related to investment strategies. Aggressive strategies are more reasonable to use when selling a new entity, while prudent strategies are more handy when founders see in a start-up a prospective business of their own.

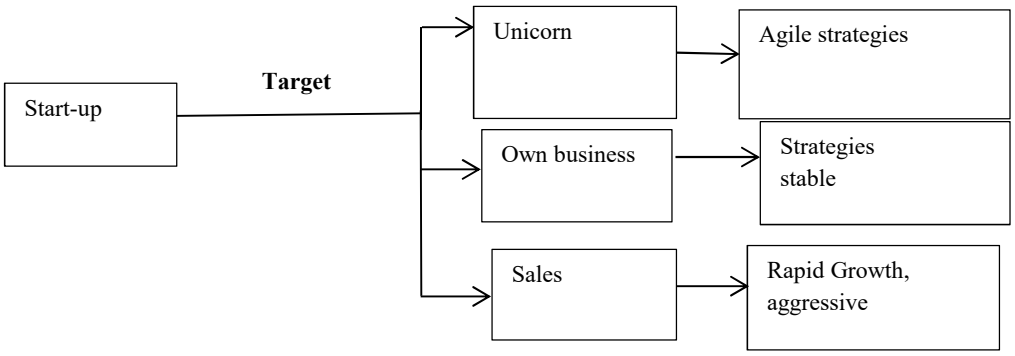


Figure 1. Start-up strategy depending on the objective.
Source: own elaboration

Regardless of the chosen management strategy, start-ups need funding sources. With this approach, it is possible to define a paradigm for their financing. With the goal of becoming a unicorn, equity alone may not be enough, especially in the long run. Funding strategies, their selection and time horizon are also inextricably linked to the life cycle of a start-up. At each stage of development, a start-up has different needs and opportunities, which determines the choice of appropriate financing sources.

According to Figure 2, the life cycle of a start-up can be divided into several key stages, each characterized by different funding needs and the availability of particular funding sources. In the first, seed stage, the start-up

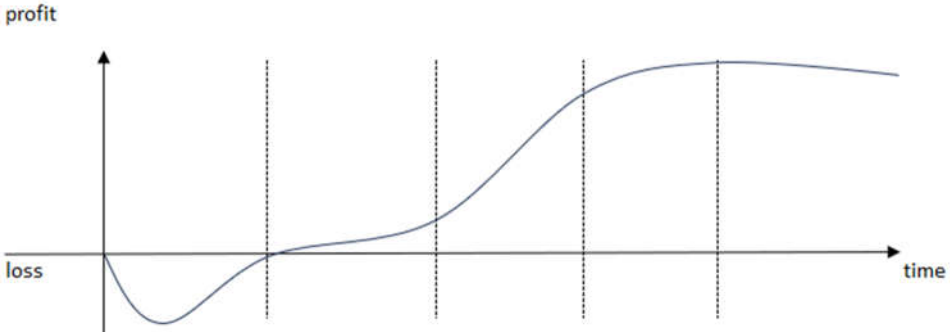
focuses on research and development, validating the idea and creating a minimally worthwhile product. The financial needs are relatively small and mainly concern the costs of prototyping, market research and basic operations. The most available and adequate source of funding at this stage is the founders' own funds (bootstrapping), possibly support from family and friends (FFF - Friends, Family, and *Fools*) and R&D grants and subsidies. Business angels and Accelerators may be interested, but only for extremely promising projects with a strong team. During the next stage, early development, the start-up already has a finished product or service and begins commercialization. Funding needs increase, covering marketing, sales, team building and further product development costs. At this stage, in addition to further bootstrapping, sources such as business angels, accelerators and in some cases equity crowdfunding become available. Venture capital funds may be interested if the start-up shows high growth potential and already has its first customers. In the next stage - growth, the start-up is expanding rapidly, gaining new customers and increasing revenues. The financing needs are significant and mainly concern scaling the business, expanding into new markets, intensive marketing and hiring staff. Venture Capital funds become the main source of funding at this stage. Business angels can continue to participate in subsequent funding rounds. The maturity stage appears when the start-up reaches a stable position in the market and generates significant revenue and profit. Financing needs are for further expansion, acquisition, IPO or strategic partnership. Available funding sources include private equity funds, strategic industry investors, bank loans or bond issuance. The final stage is the exit of the start-up. Founders and investors realize profits by selling the company or going public.

The relationship between a start-up's strategy and funding sources is fundamental. The strategy determines the financing needs, and the available financing sources affect the ability to implement the strategy and its shape. They cannot be considered in isolation from each other. In the situation of striving for unicorn status, applying agile strategies, a start-up incurs high expenditures on marketing, expansion , team building, research and development. It therefore needs significant external capital, often taking place in several rounds of financing. The founder of such a start-up should accept the loss of some control to investors and he should be ready for high risk and pressure for quick results. On the other hand, a start-up founder with a long-term own business in mind, with a strategy of stable growth, has moderate financial needs for development, focusing on profitability and soft growth, building strong customer relationships in the long term. In such a situation, there is an opportunity for the founder to rely on self-financing and profits reinvestment.

There is also the possibility of relying on debt financing (bank loans, borrowings) in such a way as to avoid excessive burden. With this type

of strategy, the founder should raise external capital, but with an emphasis on maintaining control. In quick sale strategies, the expenditures incurred are focused on achieving key metrics that make the company more attractive to potential buyers in the short term. In this situation, the founder shows a willingness to take more financial risk (e.g., taking out a loan) in order to quickly increase the value of the company. Less weight is given to long-term profitability and more to growth potential.

Regardless of the stage a start-up is currently in, a lack of sufficient financing is associated with limited opportunities for growth, expansion and product development. It can lead to premature termination, which is one of the main reasons start-ups fail. This results in a focus on survival rather than realizing a long-term vision. It is crucial that the financing strategy is aligned with the start-up's business strategy and stage of development. A start-up's strategy and funding strategy are closely intertwined and influence each other. An informed and strategic choice of funding sources, tailored to the goals, development stage and specifics of the company, is crucial to the success of a start-up. Lack of consistency between the two elements can lead to serious problems and even the collapse of the company.



Phase I	Phase II	Phase III	Phase IV	Phase V
embryo stage	**early development**	**growth**	**maturity**	**Exit**
own funds (bootstrapping)	own funds(bootstrapping)	VC funds	VC funds	sale of the company
FFF	Business angel	Business angel	loans	entry to the stock exchange
grants	Accelerator		bonds	
	Crowdfunding			

Figure 2. Start-up life cycle vs. available funding sources.
Source: own elaboration

In a situation where the owner's goal is to develop and stay in business on their own, without the condition of a quick return on investment, financing should not expose the owners to the transfer power into other decision-makers. If the goal of the company would be typically a quick return on investment and the sale of the start-up, in principle, the cost of financing, such as bank loans, should not count, since the prospect of incurring them is short, which in turn translates into lower costs. The first basic source of financing, which always appears at the beginning of a start-up's development path, shown in Table No. 1, is own funds. The scope of internal financing is limited due to the fact that it is tied to the profit made. Profits at the beginning are small, usually all of them remain reinvested, and there is no real chance of paying dividends. Staying at the beginning of the road, a start-up has no chance to develop its business solely from self-financing. At this stage, it is possible to resort to external sources of equity capital. In this area the following are distinguished: issuance of shares, additional contributions from shareholders or capital contributed by Venture Capital funds and business angels.

Product development usually benefits start-ups at an early stage. Most often, after submitting an application, a start-up gets "mentored" for several months, only to finish the time with fruit in the form of a new product or service. In exchange for shares, interested investors offer the entire resource of business advice, a negotiated amount of capital, even shared co-working space, and help expand the range of start-up locations beyond large technology centres, supporting the development of innovations in different locations. The resources offered are conducive to achieving the start-up's development goal, which may be to become a unicorn. With their support, a start-up has the opportunity to accelerate its growth and development, while emphasizing risk-taking and collaboration, in line with agile business strategies.

Similar operating principles characterize business angels. This type of financing is used by start-ups, whose goal is also to start a business and grow steadily. Angels, as individual investors or their association, by purchasing shares of the company, in addition to the committed capital, provide the start-up with a source of support in the form of extensive business experience, a network of strategic advice and business contacts. An investor's individual preferences may be the rationale for entering into such a partnership. The motivation of business angels often goes beyond the pursuit of a quick profit; the investor's personal passions and interests also play an important role. In addition to committing capital, these investors provide contacts, knowledge and experience in running a business. Close contacts and emotional involvement can also result in the business angel's active participation in the development of the start-up. The mere involvement of a well-known investor increases the value of the start-up, promotes it and

attracts the attention of future contractors and investors. There is a situation when business angels place investments in start-ups with the intention of reselling the shares at a profit. For a business angel, an investment in a start-up is associated with the risk. These investors often expect an above-average rate of return on their investment and require accurate information on how the invested funds will be spent. This can lead to interference by the investor in the management of the start-up, either as a shareholder or board member, making this method of financing less suitable for start-ups that aim to run their own business and retain full control.

Another source of financing presented is Venture Capital funds. The shares is price for this type of financing. So, it becomes obvious that this is not always suitable financing source. Especially in the situation when the goal of the start-up founders will be their own business associated with stable strategies. Originally, these funds do not aim (especially in the initial phase) for a full buyout of the company, taking up to a maximum of 50% of the shares, while this does not preclude the expectation of a high rate of return on investment. The investment period, then, as with business angels, varies up to 3 to 7 years, so it can be useful when a start-up wants to become a unicorn and uses agile management strategies. Venture capital fund invests at a high risk, in return for bringing its investor into the management structure. However, this is less interference than with business angels, leaving more space. Equity crowd funding also belongs to the group of financing in exchange for shares. It relies on crowd funding, where after presenting an idea through a dedicated platform, Internet investors receive in return the right to share in profits, as well as some decision-making power. For this reason, it will not be a suitable source of funding for businesses based on the goal of sustaining their operations. The advantage of this type of financing is the immediate vetting of the start-up, as well as promotion among the multitude of internet users. This is an attractive source of funding for start-ups focused on rapid growth and return on investment.

Table 1. Sources of funding for start-ups according to the adopted goal

Source of funding	Chances of obtaining sufficient funds	Threats	Suitability to the implemented strategy	Control of the start-up	Risks for founders
Own funds	Small	Loss of savings	Own your own business, any goal at the start	Full	High
National Accelerator/ foreign	Medium/high	Limited number of seats	Unicorn	Partial loss	Medium
Business Angels	High	Difficulty in finding an investor	Unicorn; sale	Partial loss	Average
Venture Capital	Very high	High formal requirements - due diligence	Unicorn	Partial loss	Medium
Equity crowdfunding	Variables	Potential loss of control	Sales	Partial loss	Scattered
Domestic bank loan/ foreign	Medium/Small	Changing interest rates, high service costs	Own business	Full	High (security)
EU Grants	Small/Medium	Insufficient funds	Own business	Full	Minor/None

Source: own elaboration

A different situation can be considered when the a start-up founder assumes the goal of running his own business. In such a situation, third-party capital financing in the form of bank loans and credits is considered. The bank gives the start-up a loan or credit, under certain conditions and for a certain period. The price of remaining an independent entity is only financial costs in the form of interest. However, this is not a source of financing without drawbacks. There are a number of risks as well as limitations to taking out a bank loan or credit. The form of collateral for the lender is the start-up's assets, so in the early stages of development, the founder's private property is most often pledged, which is very risky. Using such a source of financing, unlike business angels and VC funds, allows to maintain full control over the start-up and in no way affects the freedom of management. Thus, it is an advisable solution aimed at start-ups that aim to own their own business, following stable strategies.

Membership in the European Union opens for start-ups the doors of EU funds as well. EU funds are divided into operational programs, which assume a specific purpose and finance specific projects. On the one hand, they can

provide funding for projects endowed with a high risk of investment, and on the other hand have positive impact on society. In addition to grants for setting up a start-up, EU programs offer training and mentoring support. This is usually non-refundable financing, so it does not deprive founders of ownership. Compared to funding from business angels or Venture Capital funds, EU grants do not offer high amounts. On the other hand, they minimize the risk associated with the establishment of a start-up. They are recommended for stable strategies aimed at continuing their own business.

Those source of financing can be employed in the various stages of start-up development - from the initial phase (bootstrapping), through the growth phase (Business Angels, Venture Capital, Accelerators), to the eventual maturity phase (bank loans, potentially development grants). The table clearly shows which sources of financing are most useful for the implementation of each strategic goal. According to the information presented, it has been indicated to what extent a given source of financing involves a loss of control over the company, to what extent the amounts of financing are sufficient, what financial risks the founders bear when using a given source.

The start-up financing paradigm assumes that any financing in exchange for the transfer of shares is detrimental to the goal of own operations. This is because the loss of management freedom for the start-up limits the possibility of stable strategies. With such a business goal, third-party financing is appropriate, including loans, credits, leases, grants and subsidies, and aid funds. After crossing the break-even point, in further phases of development, when the start-up's strategy is to become a unicorn and when self-financing is insufficient, funding in the form of business angels, Venture Capital funds or crowd funding becomes adequate. The goal of a quick sale and return on investment entails aggressive strategies. In this context, one option is to go public, which offers the possibility of a quick return on investment. In this view, the start-up acts as a tool for quick profit but associated with significant risk level.

Conclusions

There is no one universal (*one-size-fits-all*) optimal financing strategy that is suitable for all start-ups. The choice of funding sources must be a conscious decision, taking into account the long-term targets of the founders, the specifics of the industry and the phase of the company's life cycle. In particular, the goal of becoming a unicorn implies the need to raise significant external capital, often associated with possible losing control of the company. Contrary to the pursuit of stable, long-term operations requires a more cautious approach, based on self-financing and debt financing. Equity financing (venture capital, angel investors, gas pedals) involves losing control of the start-up but is necessary for rapid growth.

Although giving up some equity to outside investors comes at a price for access to capital, knowledge and business contacts, for start-ups seeking rapid expansion, it is often the only way to achieve the scale necessary to compete in the global marketplace. These investors, in exchange for high risk, expect above-average returns, which can generate pressure for quick results and short-term strategies. Debt financing (bank loans, grants) preserves independence but limits growth rates. Although loans and credits do not involve giving up control of the company, they are a financial burden, especially burdensome in the initial phase of operations, when the start-up is not yet generating enough revenue. EU grants, while non-refundable, are usually limited in amount and require certain criteria to be met, which can limit the flexibility of operations. The paradigm of start-up financing is to closely align the goal with the choice of funding source. Start-ups aiming to become unicorns should use Venture Capital funds, support from Business Angels and Accelerators. These sources, in exchange for shares, provide high amounts of funding. On the other hand, start-ups for which the goal is long-term self-employment should rely on their own resources and possibly seek funding sources in loans or grants.

The success of a start-up largely depends on a skilful combination of an innovative ideas, an effective management strategies and adequate sources of financing. Managing the finances of a start-up requires not only knowledge and experience but also flexibility, the ability to adapt to changing conditions and a willingness to take risks. It is also important to build relationships with various stakeholder groups, which can facilitate raising capital and support at key moments of development. This article is a starting point for further, in-depth research that could verify the theses presented and provide more specific recommendations for the practice of start-up management. Specifically, future research could focus on econometric analysis of data on funding and performance of start-ups in different industries and regions. This helps to quantify the impact of different funding strategies on the probability of success.

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Paulina Kozieł[1]

DIGITAL TRANSFORMATION OF THE ENERGY INDUSTRY: USE OF DIGITALISATION AND MODERN TECHNOLOGIES IN CUSTOMER SERVICE SYSTEMS AS EXAMPLED BY TAURON POLSKA ENERGIA S.A.

Abstract

This article presents the role of digitalization and modern technologies, including artificial intelligence, in customer service in the energy sector, using the example of TAURON Polska Energia S.A. The theoretical section discusses the relationship between digitalization, digitization, and digital transformation, and highlights the importance of AI tools such as chatbots, RPA, and recommendation systems. The empirical section presents TAURON's activities, including the development of self-service services, a mobile application, digital notifications, e-invoices, and e-contracts using blockchain, the digitization of connection processes, the expansion of ICT infrastructure, and "barrier-free" initiatives. The analysis shows that digitalization increases the efficiency and accessibility of services, but also poses organizational and social challenges.

Keywords: digitization, digitalization, digital transformation, customer service, TAURON Polska Energia S.A.

JEL classification: L94, O33, M15.

[1] MSc, Institute of Management, Jan Kochanowski University in Kielce.

Introduction

The dynamic development of information and communication technologies, the widespread adoption of artificial intelligence-based solutions, and growing regulatory and environmental pressures make the energy sector a key area of digital transformation. Traditionally viewed as an infrastructure industry, the energy sector is increasingly leveraging modern technologies not only in energy generation and distribution but also in customer relationships. Customer service systems are becoming one of the main areas for implementing digital solutions – from simple e-services, through self-service platforms, to advanced analytical tools and applications powered by artificial intelligence.

In the area of customer service, digital transformation, understood as a shift in an organization's operating model based on the use of new technologies, encompasses a shift from traditional, single-channel contact to integrated omnichannel systems, as well as the use of data analytics and artificial intelligence algorithms to proactively manage customer relationships and design their service experience. Artificial intelligence-based solutions are particularly important in this context, enabling the automation of repetitive tasks, shortening service times, and increasing personalization. However, they also raise new challenges related to ethics and privacy protection, among other issues. Consequently, the digitalization of customer service cannot be viewed solely as the implementation of new technological tools, but as a complex organizational and social process requiring appropriate design, management, and impact assessment.

The purpose of this article is to demonstrate the role of digitalization and modern technologies – particularly solutions utilizing artificial intelligence – in customer service systems in the energy sector, using the example of TAURON Polska Energia S.A. The first part of the article presents the theoretical foundations of digitalization, digitization, and digital transformation, and their importance for modern customer service systems, with a particular emphasis on AI technologies. The second part presents a case study of TAURON: the characteristics of the entity, its approach to customers and customer service, and specific examples of the application of digital solutions in this area. This analysis allows us, on the one hand, to connect theoretical conclusions with management practice in a large energy company, and, on the other, to identify directions for further development and challenges related to the digital transformation of customer service in the energy sector. The article is based on desk research, a case study, and secondary data analysis, which allows for a comprehensive approach to the issue under investigation in both a theoretical and practical context.

1. Digitization, digitalization, digital transformation and modern technologies in customer service

The digitalization of customer service is one of the key dimensions of the digital transformation of service companies. The literature emphasizes that the shift from traditional, single-channel contact to multi-channel solutions – supported by IT technologies – fundamentally changes the way customer experience is designed and implemented (Gerea, Gonzalez-Lopez, & Herskovic, 2021). As V. Maheshwaram (2024) points out, the digital transformation of customer service means not only shifting interactions to online channels but also increasing customer expectations for immediate response, personalized communication, and 24/7 service availability. Digitization in customer service therefore requires the integration of traditional customer touchpoints (brick-and-mortar service points, hotlines) with electronic channels (self-service portals, mobile applications, e-services), often within an omnichannel service framework. In this context, digitalization is not merely the implementation of new tools, but a shift in the service delivery model – from reactive ticket handling to proactive customer relationship management based on information and data analytics (Majeed, Chaudhary, & Chadha, 2025).

The concepts of digitalization and digitization are closely related to digital transformation in customer service. The concept of digitization is ambiguous and can be misleadingly interpreted, although the phenomenon itself is not new.

J. D. Mejor (2012) defines it most comprehensively, pointing out that digitization is a complex process leading to the creation of digital reproductions of documents, images, and sounds, resulting from the dynamic development of technology. Therefore, digitization is the digitalization of data stored in written, printed, or other media. Digitization is sometimes confused with digitalization, but these terms are not synonymous. Digitization primarily involves converting data from analog to digital, including archiving and sharing. This process is a fundamental step in digital transformation (Kurkiewicz, 2025).

Digitalization, on the other hand, refers to broader activities related to implementing digital infrastructure and improving organizational functioning using information and communication technologies. It is the process of popularizing digital technology and introducing electronic infrastructure on a large scale. Its goal is to increase operational efficiency, which fosters increased competitiveness of enterprises and facilitates their response to market changes and new challenges. Digitalization would not be possible without digitization. In turn, digital transformation would not be possible without digitization and digitalization, because without these two processes, the basic infrastructure and foundation for implementing the related technological and business changes would be lacking (Kurkiewicz, 2025). Digital transformation, which is an extension of digitalization and digitization (Fig. 1),

is therefore the creation of a structure, strategy or organization of the entire enterprise based on new technologies (Warsewicz, 2021).

Fig. 1. Digitization, digitalization and digital transformation
Source: Warsewicz, 2021

Artificial intelligence (AI) technologies play a particularly important role in digital transformation. M. H. Huang and R. T. Rust (2018) define AI in services as the ability of systems to perform tasks requiring different types of intelligence – mechanical, analytical, intuitive, and empathetic – traditionally attributed to front-line workers.

The development of AI in customer service takes a variety of forms, from solutions invisible to the customer to systems that interact directly with the user. The literature highlights such concepts as chatbots and virtual assistants, robotic process automation (RPA) supporting back offices, recommendation systems and predictive analytics, and service robots that interact directly with customers (Huang, & Rust, 2021).

It's also important to remember that digitization and the use of AI in customer service pose significant challenges. These include ethical issues related to privacy and the transparency of algorithms, the risk of depersonalization of services through excessive automation, and the issue of digital exclusion for some customers (Maheshwaram, 2024).

The literature clearly indicates that the digitization of customer service and the use of modern technologies – particularly those using artificial intelligence – are becoming an integral element of service companies' strategies. Digital contact channels, chatbots, service process automation, and advanced data analytics are transforming both operational processes and the way customer experience is designed, creating new opportunities to improve service efficiency and quality, but also raising new research and practical challenges (Majeed, Chaudhary, & Chadha, 2025).

2. Case study of TAURON Polska Energia S.A.

2.1. Characteristics of the TAURON Polska Energia S.A. company

TAURON Polska Energia S.A. (hereinafter referred to as TAURON) is one of the leading entities in the energy sector in Poland, operating in a vertically integrated model. Its scope of operations encompasses key energy-related areas: generation, distribution, and sale of electricity and heat. Headquartered in Katowice, the company serves approximately 6 million end users in the

distribution segment, making it one of the key suppliers of electricity to households and businesses in southern Poland. Distribution operations cover a significant area – in 2024, 51.67 TWh of electricity was delivered to end users (Media.tauron.pl1). In turn, the area of operations in distribution covers approximately 18.5% of the territory of Poland (area of approximately 57.9 thousand km2), which proves the significant share of TAURON in the sector (Kosieradzki, 2025).

In relation to the financial results for 2024, the TAURON Group generated consolidated sales revenues of approximately PLN 35.4 mld (Media.tauron.pl2). EBITDA reached PLN 6.47 billion, representing an increase of approximately 18% compared to the previous year. EBITDA margin was approximately 19.9%, representing an improvement of approximately 6.9 percentage points compared to 2023 (Media.tauron.pl1). In addition, net profit attributable to shareholders of the parent company amounted to approximately PLN 585 million, which means a decrease compared to PLN 1,123 million in 2023 (Bankier.pl).

Such a broad scale of operations and social and economic significance make TAURON play an important role in the national energy transformation and the digital modernization of public services.

2.2. Customers and their service are at the center of attention of TAURON Polska Energia S.A.

In its strategy, TAURON declares that the customer is at the center of all the company's activities (Tauron.pl1). This approach means that the company prioritizes customer experience and needs as the starting point for designing products, services, and service channels. By listening to customer needs and expectations, TAURON allows them to shape its processes and offerings (Media.tauron.pl3).

In recent years, TAURON's operations have seen a gradual integration of artificial intelligence, machine learning, and robotic process automation (RPA), which is part of a broader digitalization of business processes. These technologies, in particular, support customer service by enabling the automation of repetitive tasks, streamlining communication with customers, and increasing process transparency and efficiency. The company also utilizes advanced data analytics, which enables better forecasting of customer behavior, which translates into better service tailored to their needs and expectations (Media.tauron.pl4). TAURON uses solutions enabling the digitization and digitalization of customer contact, such as: self-service platforms, electronic Customer Service Office (eBOK), mobile applications and multi-channel communication systems (Tauron.pl2). This is a response to the growing expectations of customers who increasingly prefer fast and convenient remote contact, 24/7 availability of services and personalized offers and service.

Regarding customer service, TAURON highlights several key aspects. Currently, as many as 90% of customer issues are resolved upon first contact, and 94% of remaining issues are resolved within five days. The company is striving to fully digitize customer service, eliminating paper documents (Media.tauron.pl3). TAURON presents a multi-channel approach to customer service – including 44 stationary Customer Service Points, a hotline, email notifications and the "Mój TAURON" mobile application (Tauron.pl1).

TAURON's strategy for 2025-2035 additionally indicates that one of the business priorities is to continue to put the customer at the center of attention and customer orientation (Tauron.pl3). The document also announced that the aim is to enable customers to handle as many as 80% of their matters remotely (e-contracts, e-invoices, online channels) in the near future (Media.tauron.pl5). The company also tries to recognize the needs of customers from different age groups, preferences and digital competences, simplifying both documents and applications, as well as invoices (Telekomunikacja-i-it.cire.pl).

TAURON's approach, therefore, demonstrates customer-centricity: digital channels, service quality metrics, and customer service modernization are embedded in the company's strategy and daily operations. The company is committed to building relationships, tailoring its offerings to customer needs, and digitizing and automating service significantly. In the context of implementing digital technologies and artificial intelligence in customer service, this orientation provides a favorable foundation for analyzing how TAURON adapts to changing customer expectations and leverages modern technological solutions.

2.3. Digitalization of customer service at TAURON Polska Energia S.A.

Digitalization in TAURON customer service is reflected in specific activities described below.

1. *Online self-service services (forms, e-service via website, chat).*

TAURON is developing self-service forms that allow customers to, among other things, report meter readings, change data, submit applications, or manage contracts entirely online, without visiting a physical location. TAURON reports that in the first three quarters of 2025, customers used self-service services over 12 million times, and online forms alone are used over a million times per month (Media.tauron.pl6). Remote self-service services give customers the opportunity to handle most matters at any time and at any possible moment, without having to visit the Customer Service Office or wait in a queue, which is associated with shorter service times and greater security (less traditional document flow, less data transferred during a telephone conversation, etc.).

2. The "Mój TAURON" mobile application as the main channel of digital customer service.

The "Mój TAURON" application allows customers to view contracts and invoices, check energy consumption history, make quick online payments, provide meter readings, and contact customer service (Tauron.pl4). TAURON emphasizes that "Mój TAURON" is one of the best-rated tools in the energy sector in 2025: average rating 4.6/5, approximately 2.7 million downloads and approximately 1.2 million active users, and as many as 92% of users positively evaluate the application's operation (Telekomunikacja-i-it.cire.pl). The mobile app provides customers with a single tool for managing all energy-related matters (all the most important information for the customer is available in one place, at their fingertips) – from monitoring energy consumption to payments and contacting Customer Service. Using the app, customers can also instantly pay invoices, receive notifications about payment deadlines and new documents, and manage their data more securely than with traditional paper correspondence.

3. Digital notifications (SMS, email, push notifications) about case status and payments

TAURON uses a system of text message and email notifications about the status of its cases, including the connection and service processes. Additionally, customers can use notifications linked to the "Mój TAURON" application, which remind them of new invoices or upcoming payment due dates (Telekomunikacja-i-it.cire.pl). The use of notifications increases customer convenience because it translates into a lower risk of missing a payment deadline or important correspondence, as well as greater transparency
of the case (current case status), and reduces the need to contact the Customer Service Office.

4. Electronic documents, e-contracts and e-invoices supported by blockchain technology

TAURON is implementing blockchain technology for customer service, using it to securely transmit documents, contracts, and electronic correspondence. In May 2025, the company declared that over 700,000 customers (both individual, institutional, and business) were already served using blockchain technology, and by the end of the year, over 1 million customers are expected to use the solution. The use of blockchain is expected to eliminate approximately 150 tons of paper printouts annually and increase the security of digital service (Media.tauron.pl6). More than 3 million TAURON customers already use e-invoices, which has allowed for reducing the number of paper documents by 2.3 million per year and reducing the carbon footprint by 62 tons of CO_2 (Media.tauron.pl3). The use of this solution translates into

a higher level of data security (difficulty modifying document history), faster delivery of contracts and other documents digitally instead of by traditional mail, less paper correspondence, and therefore greater convenience for the customer and a lower risk of "losing" documents.

5. Digitalization of the connection process and handling of technical issues.

The connection process at TAURON is also being digitized – customers can remotely submit applications and track the status of their case, and communication in this area is based on online channels and SMS/e-mail notifications (Telekomunikacja-i-it.cire.pl). Thanks to this, the customer benefits from shorter connection processing times, a reduction in the number of visits to stationary points and the need to submit documents in person, better transparency of the procedure (online case status), and, as a result, greater predictability of the date of completion of the connection works.

6. *Extensive ICT infrastructure (teletransmission system, intelligent network) for the quality of service.*

TAURON Dystrybucja is implementing the "Digitalization at TAURON Dystrybucja: Expan-sion of the Teletransmission System Thanks to KPO" project, which involves investing nearly PLN 40 million in an MPLS-TP standard teletransmission system across ten of the company's branches. The goal is to enable digital network supervision, remote device control, and improved monitoring, and consequently, the use of even more advanced technological solutions that will support the development and digitization of the company's operations (Media.tauron.pl7). Although this is not directly noticeable to customers, better digital network infrastructure translates into fewer failures, faster location and removal of disruptions, and better quality of energy supply – which directly affects customer satisfaction and reduces the number of contacts with Customer Service Office due to power outages.

7. Education and support in the safe use of digital channels.

The digitalization of customer service at TAURON is linked to developing customers' digital competencies and protecting them against cyber threats. The company conducts educational campaigns ("TAURON supports online security") and provides guides and e-books on safe online use. It also emphasizes that developing secure digital service channels and educational activities are among its business priorities (Media.tauron.pl8). Education in this area allows the customer to better understand the risks (e.g. phishing, fake links, use of AI by criminals), be more confident in using the company's e-channels and helps avoid fraud, which strengthens trust in digital forms of service.

8. Simplified, clear invoices and digital presentation of billing information.

TAURON has simplified its electricity billing by using an overlay with a clear summary, presenting, among other things, a comparison of consumption, payment due dates, and payment methods. Over 3 million households (over half of all TAURON customers) will receive these new, simplified bills in 2025 (Media.tauron.pl9). For individual customers, the company has also launched the first comprehensive tariff comparison tool in Poland – a tool that allows you to choose the most profitable billing model (Media.tauron.pl3). TAURON customers can also use the electronic energy advisor to select the optimal tariff for their electricity usage profile (Media.tauron.pl9). This significantly improves the understanding of the bill structure, costs and energy consumption, which reduces the need to contact the hotline only to clarify the content of the invoice and promotes more conscious management of energy consumption.

9. Barrier-free digitalization for the elderly and people with disabilities.

As part of the "Without Barriers" program, TAURON has implemented a number of digital and online solutions that facilitate customer service for older and disabled customers. These include a dedicated hotline for seniors, online chat, and a virtual assistant tailored to the needs of older people, as well as various website and service features that are WCAG 2.1 compliant, enabling access by individuals digitally excluded due to age or health (Media.tauron.pl10; Tauron.pl5). Thanks to this, older people and people with disabilities gain easier access to online services, the ability to handle matters without leaving home, and adapted tools to facilitate reading and using services.

Conclusion

Digital transformation in the energy sector is increasingly focused on customer service, which is becoming one of the main areas for implementing modern technologies. Theoretically, it was demonstrated that digitization, digitalization, and digital transformation form a coherent chain of processes leading from data conversion to digital form, through the implementation of infrastructure and information and communication tools, to a profound restructuring of business models and service delivery methods. In this approach, customer service systems are no longer solely functional as operational sales support, but are becoming a key component of corporate strategy, concentrating both customer expectations and technological potential.

The example of TAURON Polska Energia S.A. demonstrates that a large energy company can consistently and comprehensively develop digital customer service systems. This includes infrastructure-based initiatives (development of teletransmission systems and a smart grid), while implementing solutions directly visible to customers, such as self-service

services, a mobile app, digital notifications, e-contracts, e-invoices, blockchain-based tools, and solutions supporting the elderly and disabled. The centrality of the customer in TAURON's strategy, measured by service quality indicators and the desire to facilitate remote handling of most matters, demonstrates an advanced level of customer-centricity combined with the use of modern technologies.

From the perspective of using artificial intelligence and other digital technologies, the TAURON case study confirms the trends described in the literature: the automation of repetitive processes, the development of self-service channels, and analytical tools lead to shorter service times, increased service availability, and the ability to personalize offers. At the same time, the company's operational practice reveals the challenges identified by researchers: the need to reconcile automation with maintaining the quality of customer relationships, ensuring the transparency and security of digital solutions, and considering the diverse digital competencies of customers.

The conclusions drawn from the analysis have both a cognitive and practical dimension. On the one hand, they confirm the growing importance of digitalization and AI in customer service as integral elements of service company strategies, and on the other, they point to the need for further research into the effectiveness, social acceptance, and long-term effects
of implementing these solutions in the energy sector. Interesting avenues for further analysis include: comparative case studies of various energy companies, research on customer perception and satisfaction with digital services, an assessment of the impact of AI solutions on the digital divide, and in-depth economic analyses of the effects of service process automation.

In summary, the digital transformation of the energy sector – viewed through the lens of customer service systems – is not simply a matter of implementing specific technologies, but a long-term process of organizational and cultural change. The example of TAURON Polska Energia S.A. demonstrates that consistently combining digitalization, modern technologies, and customer focus can be a key factor in building competitive advantage and improving service quality in the energy sector, while simultaneously opening up new areas of responsibility and research challenges.

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Łukasz Nogaj[1]

APPLICATIONS OF ARTIFICIAL INTELLIGENCE FOR ACCOUNTING PROCESS AUTOMATION. CHALLENGES AND BARRIERS

Abstract

The text analyzes the growing role of artificial intelligence in the financial sector, particularly in accounting and auditing. It discusses the technological foundations of AI, including machine learning, natural language processing, artificial neural networks, and robotic process automation, which enhance data analysis, task automation, and anomaly detection. The author emphasizes the significance of automating accounting processes such as document recognition, transaction classification, and report generation, which improve efficiency and precision. The text highlights AI's application in fraud detection through transactional pattern analysis and in financial forecasting, where algorithms help predict market trends and manage risk. Additionally, it addresses the challenges of AI implementation, such as the need for high-quality data, implementation costs, and ethical considerations.

Keywords: artificial intelligence, accounting, process automation, machine learning.

JEL Classification: M41, O33, G17, L86.

Introduction

The rapid development of digital technologies has significantly influenced the functioning of the financial sector, including accounting and auditing. Traditional

[1] Łukasz Nogaj MSc, Casimir Pulaski Radom University, Faculty of Economics and Finance (ORCID: 0000-0002-4120-2093), e-mail: l.nogaj@uthrad.pl.

accounting methods are becoming insufficient in the face of increasing data volumes, regulatory complexity, and the growing demand for greater efficiency and accuracy. Artificial intelligence (AI) offers solutions that have the potential to revolutionize these areas through process automation, real-time data analysis, and anomaly detection.

Despite the increasing interest in this topic, there is still a lack of comprehensive analyses on the actual impact of AI on accounting and auditing, as well as the challenges associated with its implementation. The aim of this article is to fill this gap by presenting key AI applications in accounting, analyzing their benefits, and discussing potential barriers to adoption. The article not only assesses the current state of AI utilization but also forecasts its future impact on the financial sector, which is crucial for businesses, regulators, and professionals in the accounting and auditing industries.

1. Theoretical Foundations of Artificial Intelligence and Accounting

Artificial intelligence (AI) is an interdisciplinary field of science focused on developing computer systems capable of mimicking human cognitive processes, including data analysis, problem-solving, decision-making, and learning from experience (Turing, 1950). The definition of AI has evolved alongside technological advancements. The initial foundations of this field, originating from the works of Alan Turing and John McCarthy, were centered on creating machines that could simulate human intelligence (McCarthy, 1958).

Today, AI is widely applied across various economic sectors, including finance and accounting, where it enhances data processing, task automation, and financial analysis optimization (KPMG, 2024).

Currently, AI development is based on several key technologies:

- **Machine Learning (ML)** – enables systems to analyze data and identify patterns, which is used in accounting for financial flow analysis and forecasting future outcomes (Deloitte, 2023).
- **Natural Language Processing (NLP)** – allows systems to analyze and interpret written texts, making it applicable in the automatic classification of accounting documents and report generation (Nowak, 2022).
- **Artificial Neural Networks** – inspired by biological brain structures, these networks facilitate deep data processing and anomaly detection in financial transactions (Kowalski, 2021).
- **Robotic Process Automation (RPA)** – a technology that automates repetitive tasks such as invoice processing and account reconciliation (PwC, *The Impact of RPA on Accounting*, 2023).

Each of these technologies contributes to streamlining accounting processes, eliminating human errors, and improving operational efficiency in businesses.

2. The Role of Artificial Intelligence in Accounting

2.1. Automation of Accounting Document Processing

Modern enterprises strive to optimize business processes, with accounting being one of the key areas for improvement. Automating the processing of accounting documents is no longer just a trend but a necessity for companies aiming to enhance efficiency, accuracy, and competitiveness in the market. Traditional accounting methods rely on manual data entry and verification, which is time-consuming and prone to human error. The introduction of AI technologies, particularly advanced Optical Character Recognition (OCR) and Natural Language Processing (NLP), has revolutionized this process. These systems can not only scan and extract information from invoices, receipts, and bank statements but also interpret the context and meaning of the data. As a result, automated classification and accounting of documents become possible, significantly accelerating accounting processes and minimizing the risk of errors (KPMG, 2024).

Automation in accounting involves leveraging modern technologies to perform repetitive and routine tasks that were previously handled manually. This allows processes such as invoice data entry, verification, and archiving to be executed faster and with reduced error risk. A key element of this transformation is the digitization of documents and the integration of IT systems within the company.

AI-powered systems analyze vast amounts of financial data, identifying patterns and relationships that might be overlooked by human accountants. Through machine learning algorithms, these systems learn from historical data, enabling precise categorization of transactions. Automating this process not only increases the accuracy of financial records but also allows for real-time monitoring of a company's financial health. In practice, this means that the system can automatically recognize whether a transaction pertains to office supplies, service payments, or other categories, simplifying subsequent cost and revenue analysis (Enova, 2024).

Automation of accounting processes involves utilizing technologies such as:

- OCR (Optical Character Recognition) – recognition of characters in paper documents and their conversion into digital format (Kowalski, 2021).
- RPA (Robotic Process Automation) – automation of repetitive processes, such as entering invoice data into accounting systems (Nowak, 2022).
- Artificial Intelligence (AI) – analysis and categorization of financial documents, as well as forecasting accounting trends (Wiśniewski, 2020).

- Cloud-based accounting systems – enabling access to documents from any location (e.g., Xero, QuickBooks) (Król, 2021).

Automation of accounting processes offers numerous advantages for businesses, including:

- Time savings – reducing the time required for manual data entry. Modern accounting systems can automatically recognize invoice details (e.g., invoice number, amount, date, contractor's tax identification number) and assign them to the appropriate accounting categories.
- Reduction in errors – eliminating human transcription mistakes (e.g., typos, incorrect amounts). Automation minimizes the risk of such errors and eliminates the need for corrections, saving additional time.
- Regulatory compliance – automatic adaptation to changing accounting regulations, implemented at a central management level for the entire organization.
- Faster financial reporting and analysis – automated transaction recording allows real-time access to financial data, reducing the time required to prepare reports and analyses.
- Improved operational efficiency – reducing costs associated with hiring accounting personnel and accelerating the document approval process (Mazur, 2021).

2.2. Anomaly and Fraud Detection

One of the key applications of AI in accounting is transaction monitoring and analysis to identify irregularities. Anomaly detection algorithms can analyze hundreds of thousands of transactions in real time, identifying unusual patterns that may indicate fraud or errors. For example, if the system detects a transaction with an unusually high value or one made at an irregular time, it can automatically generate an alert for the auditor.

With artificial intelligence and machine learning, modern programs can detect unusual transaction patterns, such as:

- Unexpected changes in transfer amounts – for instance, a sudden increase in invoice amounts for a single supplier.
- Unauthorized transactions – recording expenses outside of regular working hours or from unknown locations.
- Duplicate invoices – double recording of the same invoice, which may indicate an error or an attempt at fraud.

Only an AI-driven system can detect that the same invoice has been entered multiple times with different document numbers, potentially indicating a deliberate fraud attempt. This approach allows for a rapid response and minimizes potential financial losses (Wiśniewski, 2020).

2.3. Financial Forecasting and Data Analysis

Artificial intelligence in accounting is becoming a key tool in financial analysis and forecasting future business performance. Traditional financial forecasting methods relied on historical data and manual analyses performed by accountants and analysts. Today, thanks to advanced machine learning algorithms and artificial intelligence, these processes can be carried out much faster, with greater accuracy and minimal risk of errors (KPMG, 2024).

Financial forecasting using AI involves analyzing large datasets, identifying patterns, and predicting future trends. These systems enable companies to better manage budgets, optimize costs, and identify potential financial risks (Deloitte, 2024).

One of the key applications of AI in financial forecasting is the analysis of historical data to predict future trends. Machine learning algorithms examine past financial results of a company, taking into account factors such as:

- Seasonal sales fluctuations
- Operating costs
- Market trends
- Customer behavior
- Inflation and other macroeconomic indicators

Based on this information, AI can generate detailed forecasts regarding future revenues, expenses, and profits (McKinsey & Company, 2024).

Traditional financial forecasting methods often rely on rigid statistical models that do not account for market volatility. AI, in contrast, can dynamically adjust its models to new data. Algorithms can learn autonomously from real-time events, allowing for more realistic forecasts (EY, 2024).

Artificial intelligence in financial forecasting utilizes various technologies that support data analytics and decision-making. One of them is machine learning (ML). Machine learning enables financial systems to independently analyze data, detect patterns, and generate forecasts. ML algorithms are used for:

- Revenue prediction
- Market trend analysis
- Detecting potential financial fraud (PwC, 2024)

Another key technology is natural language processing (NLP). With NLP, AI systems can analyze financial content such as stock market reports, accounting documents, and economic news. This allows companies to respond more quickly to market changes (Forbes, 2024).

The application of AI in financial forecasting offers many benefits, including:

- Improved forecast accuracy – AI minimizes human errors and ensures more precise predictions by analyzing large datasets (Smith, 2023).

- Faster decision-making – AI systems generate real-time forecasts, enabling managers and accountants to make financial decisions more quickly (PwC, 2023).

Despite the advantages mentioned above, implementing AI in financial forecasting also presents several challenges, such as:

- Data quality – To ensure accurate forecasts, input data must be of high quality. Poor data can lead to incorrect analyses.
- Implementation costs – Integrating AI into accounting requires investment in infrastructure and employee training (Forbes, 2024).

3. The Future of Artificial Intelligence in Accounting

Artificial intelligence is playing an increasingly significant role in modernizing accounting processes, gradually transforming the way bookkeeping, auditing, and financial management are conducted. The development of this technology is of fundamental importance for businesses striving to improve operational efficiency, reduce errors, and minimize administrative costs. According to a 2024 KPMG report, over 75% of companies have implemented at least one AI-based solution in the field of accounting and finance, and forecasts suggest that by 2030, the adoption of these technologies will encompass nearly the entire sector (KPMG, 2024).

3.1. The Use of AI in Accounting – Current State

It is important to note that there is a lack of comprehensive analyses and reports specifically focused on the use of AI in accounting. Currently, available data pertains to the overall economy and its various sectors, but there is no specific breakdown for accounting. The analysis of existing data suggests possible reasons for this situation.

According to a report by the Polish Economic Institute from June 2024, only 6.6% of Polish companies use artificial intelligence in their business processes. This is a low percentage compared to other European countries. The reasons for this include a lack of awareness of the benefits of AI, concerns about implementation costs, and insufficient knowledge about available solutions (Tygodnik Gospodarczy PIE, 2024).

Forecasts indicate growing interest in AI adoption among Polish companies. The BUZZcenter report *"Power of AI"* (2023) highlights that businesses recognize the advantages of AI, such as improved risk management, better product and service quality, and enhanced business processes. However, barriers such as a lack of awareness regarding AI capabilities, concerns about data security, and high implementation costs continue to pose challenges for many companies. The report was prepared using the CAW methodology and based on a research sample of *n=384*. The findings shed light on Polish entrepreneurs' knowledge and perception of AI and the benefits it can offer.

The report also reveals that more than half of respondents limit their AI usage to tools like ChatGPT or Midjourney. Additionally, 27% of surveyed entrepreneurs do not use any tools classified as artificial intelligence. This situation varies depending on the size of the company.

Table 1. AI-Based Solutions in Business by Company Size.

	Microenterprise (1-10 employees)	Small enterprise (11-50 employees)	Medium enterprise (51-250 employees)	Large enterprise (over 250 employees)
We use individual tools, e.g., ChatGPT	69%	60%	50%	41%
We use several tools	10%	12%	27%	11%
We have tools tailored to our needs	7%	0%	0%	14%
We are not using them yet, but we plan to implement them	7%	10%	10%	11%
We do not use them at all	7%	18%	13%	23%

Source: Own study based on Raport Power of AI. Nowe możliwości rozwoju i skalowania biznesu, Buzz Center 2023

The analysis of the results presented in the table above leads to several conclusions. Firstly, the smaller the enterprise, the fewer AI-based solutions it implements. This may be understandable given the still high costs of adopting AI solutions, including purchasing licenses and training personnel. However, this could become a developmental barrier for the SME sector in Poland in the coming years, which requires further investigation. Secondly, the percentage of micro, small, and medium-sized enterprises planning to implement the aforementioned solutions is significantly lower than that of large enterprises, which somewhat confirms the predictions above. This issue, therefore, requires more in-depth research.

Further insights into how entrepreneurs perceive AI solutions can be drawn from additional data provided by Buzz Center. The majority of respondents claim to be aware of the potential benefits of AI implementation in business – 21% responded "yes," and 38% "definitely yes." Another 37% assess their awareness in this area as average. However, in in-depth IDI interviews, it was revealed that despite general knowledge about AI's potential in business, most respondents lack clarity regarding the specific ways these technologies can be practically implemented.

A noticeable phenomenon is the perception of artificial intelligence primarily through the lens of tools such as ChatGPT and Midjourney, which stems from limited awareness of other available solutions. Respondents recognize the benefits of AI adoption, particularly in improving customer service quality and saving time, which directly translates into financial efficiency for companies (Power of AI, 2023).

These findings should be compared with data from other countries. According to *The State of AI in Accounting Report 2024*, published by Karbon, accountants worldwide predict that AI will significantly impact their industry. Most specialists believe these changes will be substantial. Despite the high interest in the topic (82% of respondents express curiosity about AI), only 25% of firms actually invest in its implementation (Carbon Magazine, 2024).

A deeper analysis of the data reveals an interesting picture: engagement in AI education appears to correlate with company size, similar to the trends observed in data on Polish firms.

Table 2. Engagement in AI Education by Company Size

		Firm size in employees					
		1-3	4-10	11-20	21-50	51-200	201+
Is AI training offered at your firm?	Yes	17%	19%	30%	35%	42%	20%
	No	78%	77%	61%	59%	39%	50%
	Not sure	5%	4%	9%	6%	19%	30%

Source: The State of AI in Accounting Report 2024, Carbon Magazine 2024

As company size increases, so do investments in artificial intelligence; however, this trend comes to a halt in large organizations with more than 200 employees. This is due to more complex hierarchical structures, a larger workforce, and the need for strategic coordination and adherence to strict procedures when implementing changes. As a result, larger enterprises are less agile, which slows their response to new trends and hinders the adoption of innovations, including AI training.

On the other hand, AI-related training is not yet widespread in small firms. In the smallest organizations, with 1 to 3 employees, only 17% allocate resources to AI education. This suggests that although small businesses often demonstrate greater adaptability, they still do not prioritize AI training or invest in it on a large scale.

In mid-sized enterprises, a significant increase in investment in AI training can be observed. Companies employing between 21 and 50 employees

implement AI education programs in 35% of cases, indicating that they perceive such initiatives as a crucial factor in building a competitive advantage and improving operational efficiency.

This trend continues in organizations with 51 to 200 employees, where the implementation rate of AI training rises to 42%. However, in firms with more than 200 employees, investments in AI education drop by more than half. As organizations expand, new challenges arise, such as more complex management structures and a limited ability to implement changes quickly, which may hinder the adoption of modern solutions, including AI training programs.

One of the most interesting aspects of the report is the data on the current use of AI in accounting. Currently, the number of accountants who do not use artificial intelligence at all (22%) exceeds the number of those utilizing it for optimizing specific processes. For example, AI is used for financial forecasting and analysis by 11% of respondents, for customer service by 10%, and for tax filings and audits by 6%.

Among accountants using AI, the most common application (59%) involves improving communication with clients.

Popular uses include:

- creating emails supported by ChatGPT,
- transcribing phone calls and meetings using AI-powered note-taking applications,
- preparing client proposals with AI tools.

Another common way AI is used in accounting is for searching work-related information – 31% of AI users indicate this as a key function. Additionally, 36% of respondents who use artificial intelligence apply it for automating accounting processes.

Key takeaways from the Report:

- Pperception of AI in accounting depends on the role within the company. Owners, partners, and managers view artificial intelligence as an opportunity for growth and are eager to invest in its implementation. In contrast, lower-level employees approach it with more caution and skepticism.
- No fear of job displacement. Most accountants do not worry that AI will replace them in their profession. Instead, they are curious about how it will impact their daily tasks.
- Concerns about ethics and client relationships. Accountants express concerns that the use of artificial intelligence may reduce personal contact with clients and pose risks related to data protection and ethical considerations.

- Modern technologies attract young professionals. Younger generations of accountants expect access to advanced tools, making AI implementation a crucial factor in attracting new talent.
- AI as a key to competitive advantage. Accounting firms believe that implementing artificial intelligence is essential for building a modern business strategy. Companies that adopt AI quickly will increase their efficiency and productivity, while those that ignore the technology may fall behind their competitors (*Carbon Magazine, 2024*).

3.2. Predicted Level of Accounting Process Automation by 2035

According to the *2024 State of Workflow Automation* report on U.S. accounting firms, the biggest challenge for the industry in 2023 was obtaining documents and information from clients. In comparison, in 2022, the primary issue was time-consuming manual tasks. While the excess of manual work can be relatively easily reduced through the implementation of accounting software utilizing Robotic Process Automation (RPA), document workflow issues require more comprehensive solutions.

A growing trend in accounting firms is the automation of document workflows. Nearly 60% of surveyed firms in the U.S. are actively taking steps to streamline this process. The most commonly adopted measures include designing efficient procedures (68%), purchasing specialized document management software (55%), and organizing employee training sessions (29%).

Document workflow automation is also becoming a key development direction for accounting firms in Poland, especially in the context of the planned implementation of the mandatory National e-Invoice System (*Krajowy System e-Faktur*, KSeF).

According to available reports and studies, accounting automation is expected to become the global standard in the coming years, incorporating increasingly advanced technologies. Deloitte's 2023 report predicts that by 2030, over 90% of accounting processes will be automated, and the role of AI in financial decision-making will increase by 250% compared to 2020 (*Deloitte, 2023*). In the future, businesses will use AI not only for recording and classifying transactions but also for analyzing financial trends and forecasting outcomes.

Predictive algorithms will be able to identify financial risks at an early stage, enabling companies to take preventive measures. AI will also enhance the analysis of operational costs and optimize tax strategies. With advancements in deep learning, accounting systems will be capable of automatically detecting financial fraud and identifying inconsistencies in financial reports, eliminating the need for manual audits in many cases (*Deloitte, 2023*).

3.3. Conclusions

The implementation and learning of artificial intelligence (AI)-based solutions in accounting is a crucial factor that can provide businesses with a competitive advantage, particularly in the small and medium-sized enterprise (SME) sector. Deploying AI enables significant reductions in operational costs through the automation of routine processes, the elimination of human errors, and the optimization of financial data management. As a result, SMEs can offer more efficient and competitive services compared to large companies, which are often less flexible and slower to adapt to technological changes.

Despite these benefits, research indicates that both in the United States and Poland, small and medium-sized enterprises demonstrate a low readiness to adopt AI in their accounting processes. This reluctance stems from various factors, such as a lack of awareness of AI's benefits, concerns about implementation costs, and insufficient knowledge of available tools. This situation calls for further scientific research to better understand the barriers faced by SMEs and to identify effective strategies for AI education and implementation in this sector.

Summary

Artificial Intelligence (AI) is playing an increasingly significant role in the financial sector, particularly in accounting and auditing, where it enables process automation, improving efficiency, accuracy, and security. With technological advancements, AI utilizes sophisticated tools such as machine learning for financial data analysis, natural language processing for interpreting accounting documents, artificial neural networks for detecting anomalies, and robotic process automation for automating routine tasks.

The implementation of these technologies significantly streamlines document processing by enabling automatic invoice scanning, transaction classification, and rapid financial report generation. AI also enhances transaction monitoring and fraud detection by analyzing patterns and identifying irregularities, increasing the level of financial control for businesses.

In financial forecasting, AI algorithms analyze historical data, predict market trends, and support strategic business decision-making, minimizing the risk of errors and enabling a faster response to market changes. Despite numerous benefits, the adoption of AI in accounting presents challenges such as the need for high-quality data, implementation costs, and ethical concerns related to data protection.

Despite these barriers, global trends indicate that by 2030, accounting process automation will become standard, and businesses will increasingly use AI to optimize financial strategies, analyze operational costs, and manage risk. In Poland, the implementation of AI in accounting is progressing more slowly than in other countries due to low awareness among companies regarding its benefits, as well as concerns about costs and implementation challenges.

However, growing interest in digitalization and legal regulations, such as the introduction of the National e-Invoice System (*Krajowy System e-Faktur*), may accelerate this process.

In the long term, AI will become an integral part of accounting, allowing companies to enhance efficiency and competitiveness in the market.

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