

# THE SPECIFICITY OF POLISH AND ISRAELI START-UPS UTILIZING MODERN ICT TECHNOLOGIES

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**Introduction/background:** The research problem was formulated by asking two research questions (RQ): RQ1: What are the similarities and differences in startup activity as observed in Poland and Israel? RQ2: What characteristics of a startup allow it to be treated as an AI-organisation? The conducted literature review allowed us to identify a certain cognitive gap (CG). CG1: There are few study reports discussing the characteristics of the European market of startups utilizing modern technologies. The study was conducted in 2018-2019.

**Aim of the paper:** The main goal of the article is to present the results of a comparative analysis of Polish startups with Israeli organizations using artificial intelligence technology (AI startups). This main goal sets the focus on the respective partial epistemological aims. TA1: To determine the current state of knowledge about the characteristics of startups in Poland and AI startups in Israel. TA2: To try and define the term AI startup.

**Materials and methods:** The research methods employed in implementing the formulated goals included: quantitative bibliometric analysis, systematic and critical review of the subject literature, text analysis and comparative analysis.

**Results and conclusions:** It was noticed that clear differences can be observed between the analyzed markets, especially in terms of the number of AI startups. In addition, an attempt was made to define the concept of an AI startup, and the determinants of AI startups were also presented. In conclusion, the authors set the direction for further research, which would be based on expanding the observation of a broader spectrum of AI startups in other European and American markets.

**Keywords:** Startup, Artificial intelligence (AI), AI-organization, AI startups, ICT.

## 1. Introduction

The dynamic market environment in which modern startups operate is characterised by the shortening lifetime cycles of products and services, the continuous development of modern ICT technologies, and the generation of large volumes of data (McAfee et al., 2012). As a result, startups tend to be described as companies characterised by a relatively high growth potential

accelerated by technology relying on innovative products or services, reflecting the practical utilisation of the knowledge they possess (PwC, 2013).

The publication addresses deliberations related to startups utilising modern technologies, with a particular focus on artificial intelligence (AI) – one of the most dynamically developing fields of modern computer science (Miller, 2011). Progressing civilisational changes force enterprises to take greater risks and create innovative organisations relying on state-of-the-art technologies (Hormiga et al., 2010). It should be noted that only startups are identified with this type of organisation, i.e. enterprises either beginning their economic activity or still at the earliest stages of business development (Spiegel et al., 2015). As we can see from the deliberations of numerous authors, the term startup is typically used to refer to new, temporary entities characterised by high potential for rapid growth and scalability, with a business model strongly relying on technology and innovation (Krejci et al., 2015). Furthermore, startups prove extremely important to the development of national economies, particularly in the context of dynamically developing markets (Kelley, and Nakosteen, 2005). As things stand right now, in the most dynamic markets worldwide startups are perceived as the new model of both economic and social growth (Olawale, and Garwe, 2010) due to their contribution to the labour markets as well as the economic growth and stability of the respective countries (Sulayman et al., 2014).

Global AI investments are still at an early stage but show a very high growth dynamic. The sectors most invested in the implementation of artificial intelligence solutions include ICT, telecommunications, financial services, as well as the automotive industry. AI tends to be most commonly employed by global leaders of digitalisation (e.g. financial services, telecommunications, online companies) and in sectors investing in related technologies, e.g. Big Data or cloud processing. At the other end of the spectrum the greatest difficulties in this respect are observed in less digitally advanced and more traditional sectors (e.g. construction, mining, healthcare, education) (McKinsey, & Company, 2017).

The main purpose of this article is to present the results of a comparative analysis conducted between Polish and Israeli AI startups which declare the use of start-of-the-art IT solutions, with a particular focus on artificial intelligence. At this point, it should be emphasised that unlike in Israel, we were not able to identify Polish analyses or registers pertaining to organisations focused on AI technologies, hence we were forced to rely on data pertaining to Polish organisations classified as startups. The reasons for choosing the Israeli market as a good comparison to the Polish market were as follows: it is in second place in the world, after South Korea (4.45%), among countries leading in terms of research and development expenditures relative to the GDP in 2019. The reported value for GDP percentage in Israel was 4.04% (Iri, 2019). In comparison, in Poland the same GDP percentage in 2017 was only 1.03% (Eurostat). The choice of the comparative market was also motivated by the availability of the register of startups implementing artificial intelligence, and Israel's third position (10.5%)

globally with regard to the relative market share of startups utilising AI technologies, surpassed only by the USA (40.00%) and China (11.00%) (Asgard, 2018).

## 2. Organisations utilising modern ICT technologies – identification of cognitive gaps

### 2.1. Quantitative bibliometric analysis

The impulse to approach the discussed problem of startups utilising state-of-the-art IT technologies was provided by a theoretical study conducted with the use of database resources of Scopus and Web of Science. The results thereof are presented in Table 1.

**Table 1.**

*Comparison of the incidence of the term “startup” in respective databases*

Database	Scopus			Web of Science		
	Query	No. of documents	Times Cited	h-index with self-citations	No. of documents	Times Cited*
“startup”	4364	***	***	3150	19 605/18 212**	55
“tech startup”	58	141/123**	6/6**	25	60/60**	4
“startup” AND “ICT”	3	6/3**	2/1**	2	0	0
“startup” AND “new technologies” OR “new technology”	0	0	0	1	0	0
“startup” AND “AI” OR “Artificial Intelligence”	0	0	0	2	1	1
“startup” AND “Israel”	0	0	0	1	0	0

\* Category of database search – article title. \*\*Without self-citations, \*\*\* Citation Report feature not available.

Source: authors’ own elaboration on the basis of: Web of Science and Scopus, July 17, 2019.

This stage of the analysis allowed the identification of three cognitive gaps (CG). CG1: There are few study reports discussing the characteristics of the European market of startups utilising modern technologies. This means that despite the wide interest of Polish and foreign researchers, a small number of publications presenting startups using AI technology has been observed. Assuming that artificial intelligence technology is treated as a trend in the computerization of organizations, according to the authors, an attempt should be made to characterize AI startups.

### 2.2. Literature review

The theoretical framework for this article has been outlined based on two scopes: the characteristics of the organization identified as a startup, and artificial intelligence technology. The scope constructed in this way allowed the isolation of startups from the group of examined organizations, and then, based on the assessment of genotypic activity and the

technologies used, it was possible to isolate startups that use AI in generating products and/or services.

### 2.2.1. Definition of a startup

First of all, we explored the meaning of the term “startup” based on the definition provided by S. Blank and B. Dorf, which identified it as a “temporary organisation in search of a scalable, repeatable, profitable business model” (Blank, and Dorf, 2013). E. Ries also offered significant deliberations on this topic, according to whom a startup can be identified as “a human institution designed to create a new product or service under conditions of extreme uncertainty” (Ries, 2012). In turn, the authors of *European Startup Monitor 2015* identified specific characteristic traits of startups by suggesting that they are enterprises active in the market for less than 10 years, implementing innovative business models and/or technologies, and working towards a significant increase in sales and/or employment (Kollmann et al., 2015). Startups have also been classified as companies closely associated with the technological sector, operating at the early stages of business development, and established with the view of solving the problems of specific users (Łopusiewicz, 2013). Numerous authors have defined startups as newly established enterprises characterised by a high growth potential and innovativeness manifested through the introduction of a new or significantly improved product, process, service or organisation. (Cegielska, and Zawadzka, 2017).

For the purposes of achieving the objectives formulated in this article, the following characteristics of startups have been identified:

- they search for a scalable, profitable and repeatable business model (Blank, and Dorf, 2013),
- they operate under conditions of extreme uncertainty (Ries, 2012),
- they rely on the processes of knowledge, information and data, operating within the context of high technology (Criscuolo et al., 2012),
- they are characterised by a high growth potential and an early stage of development (Damodaran, 2009),
- they operate within the scope of the digital sector and create new ICT solutions (Beauchamp et al., 2018).

### 2.2.2. Artificial intelligence (AI)

In turn, artificial intelligence (AI) has been defined in literature as “the capability of a machine to imitate intelligent human behaviour” (Merriam-Webster, 2019), or “an agent’s ability to achieve goals in a wide range of environments” (Legg, and Hutter, 2006). The concept of AI was first introduced by a professor of mathematics (Dartmouth), John McCarthy, in 1955. He defined AI as “the science and engineering of making intelligent machines” (McCarthy, 2007). When coining the term itself, he started from the “(...) conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that

a machine can be made to simulate it". (McCarthy et al., 1955). In yet another approach, artificial intelligence was defined as "a cross-disciplinary approach to understanding, modelling, and replicating intelligence and cognitive processes by invoking various computational, mathematical, logical, mechanical, and even biological principles and devices" (Frankish, and Ramsey, 2014). M. L. Minsky concluded that AI is "the science of making machines capable of performing tasks that would require intelligence if done by [humans]" (Minsky, 1968). The Oxford dictionary defined AI as "the theory and development of computer systems able to perform tasks normally requiring human intelligence (...)" (Oxford, 2019).

In its current state, artificial intelligence can be characterised through reference to its various applications, starting from computers capable of competing and communicating with humans, through virtual assistants, to robots dynamically processing sound and vision and able to react to a variety of sensory stimuli (Pareek, 2012). Sir Nigel Shadbolt postulated that "What we really have in AI is a whole spectrum of abilities, from programs that are smart, but they are not smart like us, to programs that are super clever in specific areas" (BBC Radio 4, 2015). L. Rutkowski presented three main approaches to artificial intelligence based on the deliberations of American researchers (Marvin Minsky, Edward Feigenbaum, Robert J. Schalkoff) (Rutkowski, 2005):

- AI is the study of machines performing tasks which require intelligence when performed by humans;
- AI is a field of computer science focusing on the technologies and methods of symbolic inference with the use of a computer, as well as symbolic representation of the knowledge employed for the purposes of such inference;
- AI entails problem solving with the use of methods modelled after the natural cognitive acts and processes of a human being via a simulation computer system.

Given the above, artificial intelligence is a technology that allows imitation of human activity through learning, interpreting complex content, reaching conclusions, and making decisions based on data processing processes. It facilitates communication with humans via certain interfaces and aims to improve its cognitive capacity in interactions with humans and possibly even replace them, not only in routine but more and more often also in non-routine tasks (Chen et al., 2016). Moreover, AI is currently increasingly used by the general public, seen in various applications both in large companies and startups, e.g. in the context of mobile devices, robotics, healthcare services, and intelligent transport (Lee et al., 2018).

The report published by Startup Genome identified the greatest increase in startup financing in the following sectors: advanced manufacturing and robotics (1386%), blockchain (1321%), agtech (1143%), artificial intelligence (464%) and fintech (460%) (2018). The percentage distribution among the aforementioned sectors was the following: advanced manufacturing and robotics (1.3%), blockchain (1.5%), agtech (3.3%), AI (5%), and fintech with the greatest share (7.1%) (Startup Genome, 2018b).

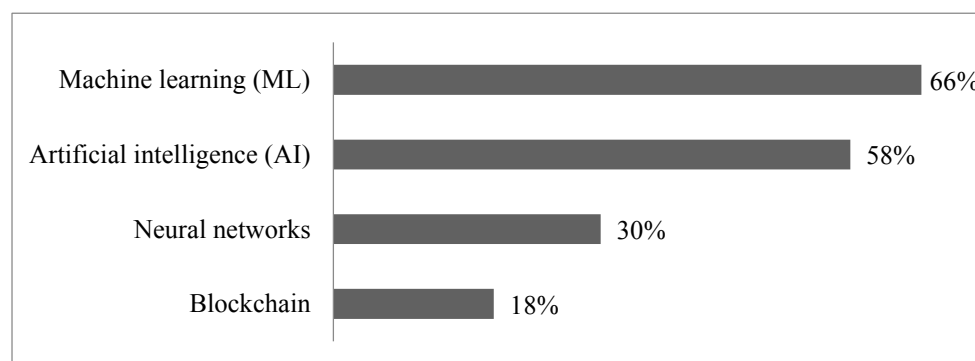
### 3. Startups creation using new technologies in the area of ICT in Poland and Israel

The concept of startup is fairly new in Poland but its popularity continues to grow. This is due to the changing economic model of the state, which now leans towards non-price competitiveness where aspects such as innovativeness and creativeness become paramount (Tomczuk, 2018).

#### 3.1. Startups in Poland

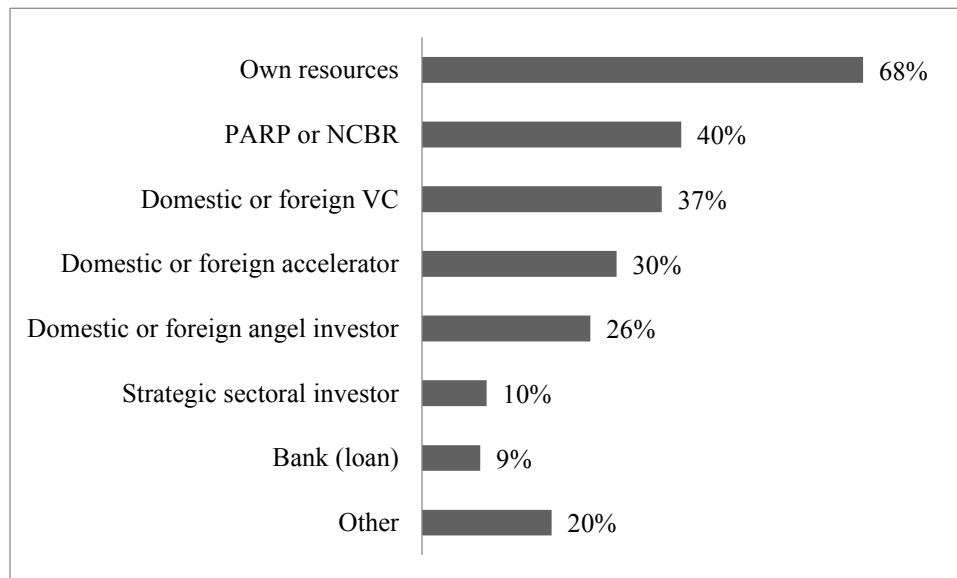
Based on the report published by the Startup Poland Foundation (2018), it can be observed that the analysed enterprises focus their efforts on three main product domains: Big Data (15%), Internet of Things (14%) and analytical solutions (13%). The most popular business model involved B2B (business to business) sales, which may suggest a considerable financial maturity of the startups. The report indicates that 83% of the respondents cooperated with other companies, a significant increase from 76% in 2017. Given the above, it may be assumed that focusing on business clients provides a better guarantee of fast profit as compared to collaboration with individual customers. Moreover, the data indicate that Polish startups generate stable revenues in the following sectors: fintech (11%), martech (10%), productivity and management (10%), education (9%), programming & development tools (9%), as well as content/social services (9%).

Interestingly, we can observe a growing popularity of innovative sectors related to, e.g. Machine Learning and artificial intelligence. A growing number of Polish companies gather considerable amounts of data, thus contributing to a database facilitating the generation of new knowledge with the use of computers. In 2018, 9% of the respondents conducted business activity related to the sale of such software, and over half of them (55%) had obtained business development financing, either from investors or from public resources. According to the report by Beauchamp et al. (2018), 37% of the analysed startups rely on one of the *deep tech* technologies (Figure 1). This indicates that the respondents develop new technologies with the use of machine learning, neural networks, blockchain, or artificial intelligence.



**Figure 1.** Popularity of *deep tech* technologies. Source: Beauchamp et al., 2018.

In terms of the sources of financing available to Polish startups (Figure 2), as many as 68% utilise their own resources, 40% rely on programs implemented by the Polish Agency for Enterprise Development (PARP) and the National Centre for Research and Development (NCBR), and 37% take advantage of domestic or foreign Venture Capital funds. Other sources mentioned by the respondents included foreign funds, angel investors, sectoral investors and banks.



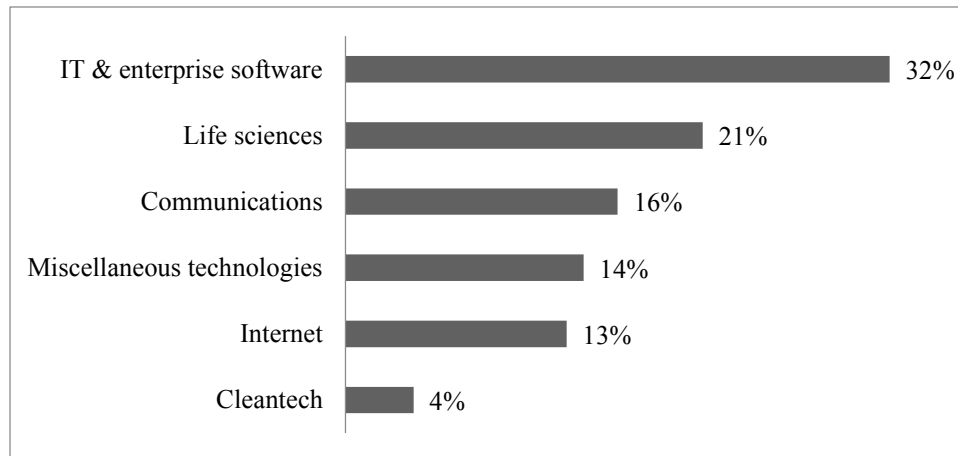
**Figure 2.** Sources of startup financing in Poland in 2018. Source: Beauchamp et al., 2018.

It is clear that Polish startups continuously strive to achieve better and more innovative results by developing new solutions, products and services in order to remain competitive, domestically or internationally. Unfortunately, once one considers the “startup nation” of Israel (the cradle of new technologies and innovativeness), Poland is still located in a rather weak position in terms of the emergence of dynamically developing young enterprises. It is also troubling to observe that Poland dedicates only 1% of its GDP to research and development, while a country such as Israel (with a population four times smaller than that of Poland) is able to allocate approx. 4.3% of its GDP to such purposes. Furthermore, the number of startups in Israel exceeds 5,000, while in Poland the number is half that at best (Money.pl). Given the above, it is important to identify the differences between the two countries that are responsible for inhibiting the development of the startup ecosystem in Poland.

### 3.2. Startups in Israel

This section of the article presents an analysis of studies and reports pertaining to the characteristics of the startup market in Israel, based on a conducted literature review. A report published by the World Bank observes that the ease of doing business score in Israel has remained fairly constant over the last three years, with an estimated increase of 0.99 in 2019, as compared to 2016 (World Bank: Doing Business, 2018). It is also important to consider the index of man days required to start a business in Israel, which decreased from 19 man days in

2010 to 12 man days in 2018 (World Bank, 2018). In the analysis of the described startup market between 2014 and 2017, a decrease in the number of new startups was observed, from 1010 in 2014 to 700 in 2017 (NoCamels.com; Startup Nation Central, 2018). At the same time, there was an observable increase in startups being closed down. In 2014, the number was 221, in 2016 – 468, and in 2017 – 408 (NoCamels.com, 2018). Fig. 3 presents the share of exit deals for startups in Israel in the 1st half 2018. Notably, a decrease in the number of exit deals for startups in Israel was reported from the first half of 2014 to the first half of 2018 from 69 to 56 (Startup Nation Central; NoCamels.com; IVC Research Centre).

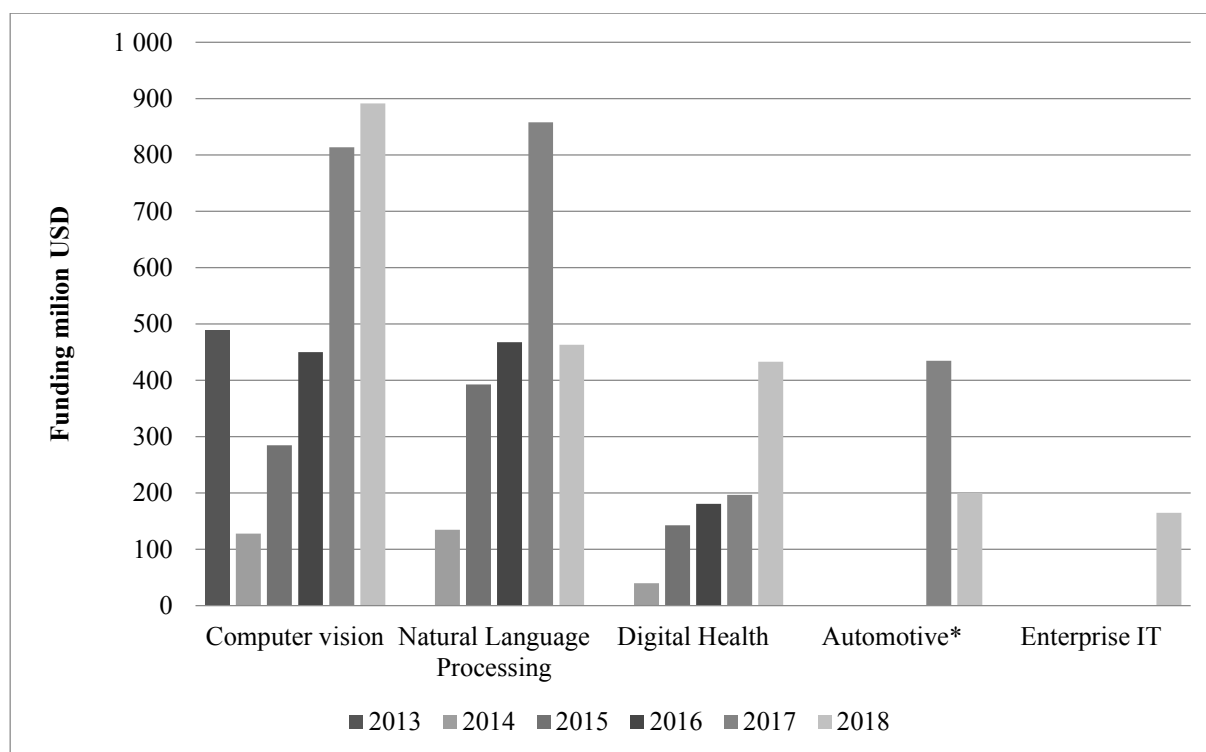


**Figure 3.** Share of exit deals for startups in Israel in the 1st half of 2018, by industry. Source: IVC Research Centre, 2018.

In the context of the Israeli startup market, one also has to consider the value of subsidies from the Israel Innovation Authority, which in 2017 in the startup sector ranked second, reaching 333% (Grant value in million Israeli Shekel) (Israel Innovation Authority, 2017).

Among the various types do startups emerging in Israel, the focus of this study was on the ones taking advantage of modern technologies. Fig. 4 illustrates the financial support received by the Israeli AI startups (artificial intelligence startups), by segment, in 2014-2018. The market share of Israeli organisations utilising AI technologies, on the worldwide scale, is 10.5% (Asgard, 2018). According to the report published by Roland Berger, the number of AI startups in Israel was estimated as 362 (Roland Berger, 2018), whereas for the purposes of the comparative analysis presented in this article, 885 organisations were identified based on data available at [startuphub.ai](http://startuphub.ai) (as of October 2018).





**Figure 4.** Funding of artificial intelligence startups in Israel by segment. Source: authors' own elaboration on the basis of Statista.

At this point, it should be noted that while the number of AI startups continued to grow between 2000 and 2015, a decrease thereof was observed in 2015. Moreover, the number of newly established startups was lower in 2017 compared to that in 2012 (Statista, 2018).

Based on an empirical study conducted in 2018 in the selected population of AI startups in the Israeli market, an attempt was made to evaluate the maturity of the organisations. As can be observed from the presented results, the largest number of organisations were classified, under the MMPM model (Sliż, 2018a, Sliż, 2018b), at level one (L1 E+), characterised as a condition wherein the organisation of management is functional but there are certain indications suggesting the possibility of long-term improvement. Moreover, the described results evidence a high share of respondents focused on the aspect of streamlining facilitated by all employees and innovation introduced in line with the customers' requirements (Sliż, 2019).

#### 4. Results and discussion

Based on the above information as well as data obtained from other sources, the below table was prepared with a juxtaposition of the startup markets in Poland and Israel (Table 2).

**Table 2.***Basic information about the startup markets in the compared regions*

Country/market	Israel	Poland
Stage of development	Product market	Solution-product fit
Pace of development	Dynamic	
Founder's profile	No data	Experienced persons in their thirties, university graduates, mainly from Poland
Financing	External financing	Own resources
Level of value produced (product, organisation, market)	Product/service	
Operating risks	No data	High (legal, personnel, financial barriers)
Role of the state	Funding	Support
Scope of activity	New technologies	
Outside relationships	No data	Collaboration with research centres
Areas of operation	Technologies	SaaS
	Enterprise	Tools for developers and programmers
	Healthcare	Natural sciences/health sector/biotechnology
Types of relationships by user type	B2B	
IT tools and technologies used	Machine Learning	Observably growing popularity of innovative sectors such as Machine Learning or AI
	AI	
	Deep learning	
Approach to innovation	High percentage of startups utilising modern ICT solutions	Development of new products and improvement of existing solutions
Predominant type of services/products	Software	Big Data
		IoT
		Analytical tools

Source: Authors' own elaboration on the basis of [startuphub.ai](http://startuphub.ai) (October 2018); Beauchamp et al., 2017, 2018; Białek, and Nowak, 2018.

The conducted analysis reveals many significant differences between the two compared markets (see Table 2). The most important pertains to the level and dynamics of startup development. The number of startups in Poland continues to grow but still remains low compared to that observed in Israel as well as in other leading markets worldwide. One should also point to the observed growing popularity of innovative technologies in Poland, e.g. machine learning or artificial intelligence, which were revealed to be dominant in the Israeli startup market. Israeli AI startups are currently at the stage of product market, take considerable advantage of outside financing, and utilise modern ICT technologies. In turn, Polish startups mostly rely on their own sources of financing and develop new products or improve on existing solutions at the stage of solution-product fit.

Given the areas in which Israeli AI startups operate, their activities are primarily focused on the following categories: technologies, enterprises, healthcare, and marketing. Polish startups, on the other hand, develop SaaS, create developer and programmer tools, as well as focus on natural sciences, the healthcare sector, and biotechnologies. Both Polish and Israeli startups emphasise the importance of dynamic development and tend to opt for B2B interaction with the market.

## 5. Conclusion

The presented comparative analysis of the Polish and Israeli startup markets was intended as a preliminary study. Based on the conducted empirical research, three general conclusions can be formulated.

First of all, clear differences can be observed between the analysed markets, particularly in terms of the number of AI startups. Based on the analytical results, it can be theorised that these two markets constitute two extreme ends of the spectrum of utilising the benefits stemming from the availability of modern ICT solutions and the degree of their implementation.

Secondly, an attempt was made to define the concept of an AI startup. It was identified as an organisation characterised by an innovative business model adapted to the needs of its turbulent milieu, engaged in the development of technological solutions, both in terms of software and hardware, with the use of artificial intelligence.

Thirdly, the determinants of AI startups were presented, including: business activity based on the creation of high technologies capable of imitating humans, their efficiency and behaviour; relying on intelligent machinery designs; high flexibility and growth dynamics; focus on the capacity to flexibly respond to the phenomenon of prosumption, interaction with the market based on the B2B model or hybrid B2B-B2C models, and operation within the areas utilising modern information and communication technologies in sectors such as, e.g. telecommunications, financial services, healthcare, marketing, and the automotive industry.

The authors set the direction for further research, consisting in extending the observation of a broader spectrum of AI-startups in other European and American markets.

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