



The Hackathons as a First Step to Build Digital Competences

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ABSTRACT:

Over the last few years, RST-TTO, as an organisation that supports the development of innovation and space technology transfer in sectors such as monitoring and prevention of natural disasters, defence and security, has organised and conducted four international hackathons and two competitions for innovative ideas. Hackathon organisation provides a broad basis for the selection of new innovative ideas in the field of Critical Digital Competencies and is a prerequisite for the creation of start-up and spin-on/off companies. The purpose of this article is to analyse and summarise the experience gained and to propose initiatives to systematise the use of hackathons as an important first step in building digital competence and entrepreneurial skills.

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Introduction

Building digital skills is important to keep up with the fast-changing environment. Digital skills can help foster entrepreneurship, build competitiveness, and solve issues of the 21st century societies. Global knowledge economies and the

rapid integration of information and communication technologies (ICT) make the acquisition of digital skills an imperative.¹ Yet, the challenges to build such skills remain, and require continuous efforts by both formal education institutions and other players.

Entrepreneurship skills are widely viewed as another critical factor for the new economy. Entrepreneurship is associated with risk-taking, focus on solving consumer or societal problems, creative solutions. It is increasingly becoming part of formal education system but also promoted through various informal learning instruments.

One informal learning platform that can serve the development of both digital and entrepreneurial skills is the hackathon. Hackathons are intensive, competitive events during which team activity is focused on solving a specific problem (digital) or creating a viable business idea and business model (entrepreneurial aspect).²

The aim of this paper is to analyse the experience of hackathons and their contribution to building digital competence and entrepreneurial skills in Bulgaria. The approach draws on extant literature on benefits and success factors in running hackathons and presents a qualitative study of four hackathons and two competitions organized by RST-TTO during the period 2019-2022. The results from the fix events discussed in this paper support previous findings on hackathons' role in supporting the development of digital competences and encouraging teams to go for establishing own start-ups to commercially exploit their projects.

The rest of the paper is organised as follows. Section 2 outlines the theoretical background and reviews relevant studies. Section 3 describes the methodology followed for the development of this research. Section 4 details the hackathons and competitions experience and the main findings. The last section summarises the results of the research and highlights the practical implications.

Theoretical background

With the advance of ICT and transition to Economy 4.0, digital technologies continue to spur innovation and entrepreneurship. ICT are changing everyday life of businesses, employees, consumers. Still, building digital competence is a challenge, even for the generations which grew up with such technologies. Familiarity with ICT does not necessarily entail being able to use ICT in a competent way, and even 'digital natives' should not be treated a priori as digitally competent.³

The need to focus in a systematic way on building such competences has been recognised by policy makers⁴ and organisations providing formal and informal education and training. Digital competencies are critical in the fast-paced knowledge economy, and largely seen as a driver of organisations' competitiveness and innovation capacity.¹ Still, there is a growing awareness of the gap between existing and needed digital competencies of employees.⁵ Van Laar et al.¹ summarise extant empirical research and identify seven core 21-st century digital skills dimensions – technical, information management, communication,

collaboration, creativity, critical thinking, and problem solving. The authors add five contextual dimensions – ethical awareness, cultural awareness, flexibility, self-direction, and lifelong learning.

Hackathons are gaining popularity as an informal learning platform which bring together an (often) technically-diverse groups tasked with a specific challenge. Traditionally, hackathons are meant to be sprints of coding for problem solving, which happen in an intensive, timed format, via competition between self-assembled teams of programmers and designers. Empirical evidence demonstrates a number of other benefits from hackathons, such as fostering entrepreneurial citizenship,⁶ developing design, project and entrepreneurial skills,⁷ promoting digital innovation,⁸ entrepreneurial learning.² In an entrepreneurial context, hackathons typically focus on developing a viable business idea and the associated business model. Szymanska et al.² demonstrate that hackathons are an effective model for entrepreneurial learning, developing entrepreneurial skillset and self-efficacy.

Briscoe and Mulligan⁹ classify hackathons into two large groups: tech-centric or focus-centric. Tech-centric hackathons focus on software development employing a particular technology or application, and may include (1) single-application, focused on improving a single application; (2) application-type, focused on a specific platform or (3) technology-specific which use a specific language, framework. Focus-centric hackathons may target software development as well as address or contribute to a social issue or a business objective. These may also be referred to as applied hackathons and include (1) socially-oriented; (2) demographic-specific or (3) company-internal.

Thus, hackathon do not target only tech-savvy participants and tech-oriented problems to be solved. In the case of focus-centric hackathons, cross-functional expertise and skills within teams may add substantial value to the outcome.

Given the wide scope of issues that might be addressed through hackathons, these may be employed by various types of organisers. Educational institutions and non-governmental organisations would typically focus on getting non-professional people, such as students and enthusiasts, to contribute and build essential skills towards working in small technical or non-technical teams. The main benefits would be associated with improvement and building skills of participants for their further career development. Hackathons can be conceptualised as an example of problem-based learning, positively influence knowledge acquisition in some settings, as well as problem solving skills, critical thinking, teamwork and self-directed learning outcomes.²

Companies could organize hackathons to pick the brains of a larger group of skilled participants aimed at solving a particular issue – often a project that has the potential to turn into a viable product. Usually, companies construct their challenges in a form of a competition and winning such a hackathon could lead to forming a start-up. Often small and medium-sized companies have the intention to scale vertically, but do not have the time and resources to work on ideas that could provide this scalability. Such companies organise internal hackathons during which all employees are only focused on developing potential ideas. This

provides the opportunity for vertical scale, which in some cases is essential. It also brings up the morale in the company as employees feel they are working on something that provides value.

Methodology

The purpose of this paper is to analyse and summarize the experience gained during the organisation and running of four hackathons and two competitions by RST-TTO in Bulgaria. To do so, this paper relies on qualitative study of the six case studies envisaged.

The paper assesses the specified skills and experience gained in use of Earth Observation and space data and services, dedicated software products and resources. In the frame of the two editions of the Copernicus Hackathons 2019 and 2020, questionnaires to the participants were employed to gather the necessary information. As a reference for measuring the digital competences at general level, the EU Digital Competence Framework was used.

The participants

Overall, 180 Bulgarian and foreign participants took place in the six events. The organizers targeted university students, PhD and young researchers, entrepreneurs in Tech, ICT and non-tech fields as Geography, Geodesy, GIS, and thematic experts in different fields.

Events

Hackathons and competitions took place during the period 2019-2022. Due to Covid-19 Pandemic four of them were conducted online and two – as physical events.

During each competition Information Sessions were organised in order not only to attract registration of participants but also to provide basic training in the area of using aero-space and geospatial data and technologies for different thematic applications and development of added value products and services. Sessions were led by mentors specifically attracted for separate editions to present, lecture and provide practical training in order to increase digital competences of teams. Additional aim of these sessions was to support and facilitate the process of matchmaking between individually registered participants.

The prize pool for local competitions was designed and realised in such a way that teams have the opportunity to further develop their idea – technical and business mentoring, online training courses in the area of processing Earth Observation data, cloud resources to retrieve higher level products and last but not least visits to specialised laboratories for Earth Observation data processing, etc.

Space technologies in support of digital competence – experience in Bulgaria

Table 1 below summarises information about the hackathons and competitions conducted by RST-TTO team which are analysed in this paper. The text below gives additional information for each of the cases.

Table 1. Overview table of the conducted and analysed innovation hackathons and competitions.

Name of the competition	Challenges	Results
Copernicus Hackathon Sofia 2019 (in presence edition)	1. Emergency management 2. Environmental protection 3. Marine and coastal monitoring, 4. Precision agriculture 5. Participants to propose their idea on how to use Copernicus Earth Observation data to develop an added value product.	✓ Increased knowledge in using Copernicus Earth Observation data and services ✓ Use of new specialised software products and cloud resources
Copernicus Hackathon Sofia 2020 “Space Hack-ing Covid-19” (online edition)	1. Smart cities 2. Monitoring of Danube and the Black Sea 3. Earth Observation and Artificial Intelligence for E-government	✓ Increased knowledge in using Copernicus Earth Observation data and services ✓ Use of new specialised software products and cloud resources ✓ The winning team have continue to develop further their work after the Hackathon - enlarging the team and conduction of user meetings
ActInSpace 2020 Bulgaria (online edition)	More than 40 challenges including patents which are property of the French Space Agency and European Space Agency	✓ Increased knowledge in using Earth Observation and space related data and services ✓ Use of new specialised software products
Copernicus Masters 2021 Bulgaria	10 challenges dedicated to health, environmental protection, agriculture, transport, etc.	✓ The winning team from Copernicus Hackathon Sofia 2020 won the edition and

Prize (online edition)		continues to develop further their work
Galileo Masters 2021 Bulgaria	10 challenges dedicated to health, environmental protection, agriculture, transport, etc.	✓ Looking for funding opportunities, assessing options to register a start-up
Prize (online edition)		✓ Increased knowledge in using navigation data and services
DefInSpace 2022 Bulgaria (in presence edition)	Space traffic management	✓ Use of new specialised software products
		✓ Increased knowledge in space traffic management

Copernicus is the European Union's Earth Observation programme, looking at our planet and its environment to benefit all European citizens. The Programme is managed by the European Commission and implemented in partnership with the EU Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-Range Weather Forecasts (ECMWF), EU Agencies and Mercator Océan. It offers information services that draw from satellite Earth Observation and in-situ (non-space) data. These services are provided freely and openly accessible to users.¹⁰

The Copernicus Hackathon Programme is part of the European Commission's Copernicus Start-up Programme, originated to stimulate the generation of new business ideas based on Copernicus data and services.¹¹

The Copernicus Hackathon Programme co-funded the organisation of 40 hackathon events. The coordinator for the implementation of the two editions of the Copernicus Hackathons Sofia, organized by RST-TTO, is AZO GmbH, Germany.

Copernicus Hackathon Sofia 2019

The initiative was funded by the European Commission, implemented by AZO and RST-TTO as a local organiser of the first Copernicus Hackathon organised in Bulgaria. The event took place in the period 19th-21st April 2019 in the Technical University of Sofia and was organised under the patronage of the Ministry of Economy of the Republic of Bulgaria. The main partner of the event was the Center for Excellence – “Universities for Science, Informatics and Technology in e-Society” (CoE-UNITE). The event attracted additional partners – CREODIAS, Planter, CloudSigma, United Bulgarian Bank, Faculty of German Engineering Education and Industrial Management, Technical University of Sofia, EARSC and

others. For two days 50 participants matched-up in 13 teams and tackled challenges using Earth Observation data in the following areas: Emergency management, Environmental protection, Marine and coastal monitoring, Precision agriculture. The participants were also allowed to propose their own idea on how to use Copernicus Earth Observation data to develop an adding-value product.



Figure 1: Copernicus Hackathon Sofia 2019 Opening, 19 April 2022, Technical University – Sofia, Bulgaria.

Two Information Sessions were held in Sofia and Veliko Tarnovo in order to provide basic information about the hackathon and theoretical and practical training to use Sentinel open access data with open source software and cloud processing resources.

Copernicus Hackathon Sofia 2020 “Space Hacking of Covid-19”

The event was held in the period 24th April – 8th May 2020 under patronage of the Ministry of Economy and the Ministry of Education and Science of the Republic of Bulgaria. It was the first Copernicus Hackathon held online due to the Covid-19 pandemic restrictions. The main partner of the event was Sofia Tech Park. It attracted additional partners including CloudSigma, CREODIAS, EARSC, EURISY, Space Research and Technology Institute at the Bulgarian Academy of Sciences, and others. 29 participants from Bulgaria, Greece and Belgium matched up in 8 teams and tackled challenges in the following areas: Smart cities, Monitoring of Danube and the Black Sea, Earth Observation and Artificial Intelligence for E-government. Additional three topics, related to the impact of the COVID-19 pandemic and the use of Earth Observation technologies were added to the main hackathon topics.

A series of online webinars were conducted during one week with presentations from leading experts from Bulgaria and Europe in the area of Earth Observation data, business incubation and cloud computing resources.

ActInSpace 2020 - Bulgaria

The international hackathon was the first edition of the ActInSpace Hackathon initiated by the French Space Agency (CNES), organised from Aerospace Valley and supported by the European Space Agency. It was held in Bulgaria 13-14 November 2020 in online format, due to Covid-19 pandemic. The event was organised in online format under the patronage of the French Embassy in Bulgaria, with the support of the Ministry of Economy of the Republic of Bulgaria and in partnership with GEO University, GIS Transfer Centre, BRIGHTCAP Ventures, Sofia Tech Park, Space Research and Technology Institute at the Bulgarian Academy of Sciences, French-Bulgarian Chamber of Commerce and Industry, and others.

Webinars run by the challenge partners were conducted. The 44 challenges included using of real patents of the CNES and the European Space Agency and the topics covered variety of themes: satellites, unmanned aerial vehicles, aerospace engineering, telecommunications and navigation, security, lasers, antennas, robotics, optics, materials science, information technology, Artificial intelligence, Internet of Things, Earth observation, environmental protection, climate, agriculture, healthcare and others.

Copernicus Masters 2021 – Bulgaria Prize

The Copernicus Masters is the leading innovation competition for commercial Earth Observation applications. The competition awards prizes to innovative solutions, services, and business concepts that use Earth Observation data to solve important societal and environmental challenges. Submissions have been open between 19 April - 19 July 2021.

In the previous edition of the Copernicus Masters 2020 on the final, a Bulgarian team won the “Environment and Health Challenge” of the German Aerospace Center (DLR) with idea for web-based geographic information and notification system for water reservoir management.

RST-TTO as a Copernicus Prize Partner 2021, with the support of the Ministry of Economy of Republic of Bulgaria supported the awarding of innovative solutions, development and ideas that use EO data to tackle challenges faced by business and society.

Participants in the Copernicus Masters 2021 were welcomed to submit their innovative EO application or service to ten challenges offered by the following partners: European Space Agency, the European Commission, the German Aerospace Center (DLR), Planet, BayWa, UP42 with Airbus, the German Federal Ministry of Transport and Digital Infrastructure, and Portugal Space (the Portuguese Space Agency). The rewards ranged from cash or direct access to commercial Earth Observation data to expert support and incubation of winners' business endeavour.

Partners for the local edition of the competitions were the Ministry of Economy of the Republic of Bulgaria, EARSC, Agricultural University – Plovdiv, and the Faculty of German Engineering Education and Industrial Management, Technical University of Sofia.

Challenge partner of the competition have conducted online presentation of the challenge topics and a number of experts were available online during the period of submission to answer questions and provide more information about the challenge.

Galileo Masters 2021 – Bulgaria Prize

RST-TTO as a Galileo Prize Partner 2021, with the support of the Ministry of Economy of Republic of Bulgaria supported the awarding of innovative solutions, development and ideas that use satellite navigation data to tackle challenges faced by business and society.

Entries were open on 19 April 2021 till 19 July 2021. Submissions had to demonstrate innovative use of Global Navigation Satellite System (GNSS) data across a wide variety of ten challenge topics.

The Galileo Masters awards prizes to services, applications and business cases that use Galileo and GNSS data to tackle important challenges faced by business and society. The main target group included SMEs, start-ups, universities and individuals in the fields of business, research, and higher education, who were welcome to submit their application services and product solutions.

The partners of the 2021 edition included the European Union Agency for the Space programme (EUSPA) with four challenges, the German Aerospace Centre (DLR) together with the German Federal Ministry of Transport and Digital Infrastructure (BMVI) and the European Space Agency (ESA).

In addition, participants were able to choose from a variety of international Galileo Prizes, organised regionally and co-funded by the European Commission. The Galileo Masters is complemented by the Galileo Incubation programme, co-funded by the European Commission to empower the transformation of great business cases into commercially viable solutions through a tailored business incubation programme. The top six winners of the Galileo Masters 2021 had access to this incubation prize, if eligible.

Partners of the competitions for the local edition were the Ministry of Economy of the Republic of Bulgaria, EURISY, Agricultural University – Plovdiv, and the Faculty of German Engineering Education and Industrial Management, Technical University of Sofia.

Dedicated webinars were held in order to provide more information about the challenge.

DefInSpace 2022 Bulgaria

The competition was held on 3-4 June 2022 as a new accompanying event within the framework of the International Defence Equipment and Services Exhibition “Hemus 2022”. It was organised by the RST-TTO, Bulgarian Academy of Sciences, under the auspices of the French Embassy in Bulgaria and with the

support of the Ministry of Defence of the Republic of Bulgaria and Hemus-95 Foundation.

DefInSpace 2022 was the first international competition for innovation with a focus on the application of space technology in the field of defence and security. It was initiated by the French Space Command in France (Commandement de l'Espace) and organised by the French Aerospace Cluster “Aerospace Valley” in 2021.



Figure 2: DefInSpace 2022 Bulgaria Opening, 3 June 2022 at “Hemus 2022” Exhibition, Plovdiv, Bulgaria.

Eleven teams took part in the competition, nine of which were representatives of higher military academies and universities in Bulgaria.

Success Stories – Building Digital Competence

In 2010, the European Commission’s European Strategy 2020 recognized digital competence as a fundamental basic skill and in 2013, the EC published the European Digital Competence Framework for Citizens, also known as DigComp. DigiComp offers a tool to assess and improve citizens’ digital competences. Currently DigiComp framework is in version 2.1 [4] and defines 21 competencies mapped to 5 competence areas:

- Information and data literacy
- Communication and collaboration
- Digital content creation
- Safety
- Problem solving.

Analysis of the hackathons and innovation contests, conducted by RST-TTO and presented above have led to increasing the level of digital competences of the participants, as per the European Digital Competence Framework, in the areas of Information and data literacy, Communication and collaboration and Problem solving and especially in software and data usage.

During the two Copernicus Hackathons surveys were conducted to assess the events by different criteria. The analyses of the Copernicus Hackathon 2019 of the preliminary survey at the Info day showed that only 1/3 of the participants have experience in processing of satellite or other spatial data, 2/3 have used geospatial software and regarding the use of cloud based virtual machines - 1/3 have never used, and the other have used only as a basic user.

The results from the post-hackathon survey show that generally the participants were satisfied from the introductory presentations provided. More satisfaction from the mentoring, compared to the technical training and less for the business consulting, which we have taken into account and have provided more lectures in the business consulting in the next edition of Copernicus Hackathon in 2020.

Success Stories – Entrepreneurial Development Spurred by Participating in the Hackathons

RST-TTO continued to follow the progress of the participating teams, and to assist where necessary and possible. Some of the teams have decided to continue developing their ideas and potentially start up companies. Below are two of the success stories tracked.

Success Story 1: A team of three people consisting of a developer, data scientist and a lawyer each of whom with no prior knowledge of Earth Observation data and sensors were working on a project regarding classifying and tracking landslides using Sentinel 2. By discussing the topic with one of the Hackathon mentors, who had field knowledge, they were able to successfully develop their idea and won second place. The Copernicus Hackathon Sofia 2020 helped them develop knowledge of how to work with satellite imagery as well as what types of satellites are out there and how to use them appropriately. In addition to that they also developed competency in algorithms closely used by field experts.

It is interesting to note that the same team came back to the second round - for the Copernicus Masters Bulgaria Prize 2021. They had further improved their knowledge of Earth Observation but this time developed a different project in the area of smart agriculture. They were mainly interested in creating a start-up and having completed the Hackathon they felt more confident and knowledgeable relative to building a business plan and running a company. The team was invited to participate in the National Research Programme “Smart crop production” started in 2021 to support RST-TTO in the development of applications using Earth Observation data and AI for the smart agriculture.

Success Story 2: Another team started their success story by participating in the online edition of the Copernicus Hackathon Sofia 2020. Initially consisting

of a health specialist, physician and a software engineer they won the Hackathon with a solution using Sentinel's satellite data about air quality monitoring. The team have continued their work after the hackathon by participating in other online format hackathons, conducting user interviews and searching for incubation and funding opportunities. There was motivation to register an SME as this was required for some acceleration programmes.

They grew bigger and participated in the next level of innovation contests under the Copernicus innovation programme – the Copernicus Masters Bulgaria Prize in 2021 where their further developed solution won first place. The team is continuing their research and going to market strategy to commercialise their added value products.

Conclusions

Hackathons widely seen as an effective instrument to support building digital competence, boost organizations innovative and competitive capacities, as well as lead to the establishment of new innovative start-ups.

The experience presented in this paper is based on four hackathons and two competitions conducted during the period 2019-2022 by RST-TTO in Bulgaria. The time lapsed after the first events gives us the ability to follow up with participants and teams' development and to assess the effects of the events. Participation was widely assessed by participants as beneficial in several areas, including access to highly experienced mentors, access to technologies many of the participants were not familiar with before, international exposure (both to mentors and participants from other countries), competitive environment which helped boost entrepreneurial spirit. The two success stories discussed above are of two teams who decided to further develop their projects and aim to start up companies to commercially exploit them.

Thus, the Hackathons, which are a new tool for Bulgaria to set-up innovation process, clearly show their effectiveness for the development of the national ecosystem of space research and technologies, through the use of IT solutions based on new methods such as Artificial Intelligence (AI), Machine Learning, Big Data, etc.

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