PROJECT MANAGEMENT PROCESS DIGITALIZATION HEATMAP IN EU FUNDED RESEARCH AND DEVELOPMENT PROJECTS

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ABSTRACT
Today, EU projects represent a significant factor in growth and progress of the Croatian economy. Since Croatia joined the European Union, it has utilised a significant amount of HRK for research and development projects. Research and development projects have a long lead time—over four years on average—from the beginning of the idea to the end of implementation. Several stakeholders are involved in the process, including institutions, academia, SMEs, and consulting firms. The level of readiness of the process for digitalisation varies depending on the project lifecycle phase. Since digitalisation is widely recognized as the key to success in service businesses, this study aims to establish a digitalisation heatmap for administrative and operational processes in the EU-funded research and development project lifecycle and recognize opportunities for digitalisation of the process. Data were collected through an empirical study of EU-funded project. Taken together, these findings suggest that there is a potential for further digitisation of the process, especially for consultants in the implementation phase and communication with the client as well as in state institutions. Further research should focus on identified subprocesses to successfully develop a methodology to increase digitisation readiness and on extraordinary circumstances that result in changes of lesser or greater significance to the project.

KEYWORDS
Project management, Digitalisation, R&D projects, EU funding, Process mapping.
1. INTRODUCTION

1.1 Digital transformation in Croatia

Industry 4.0, the term first used in Germany in 2011, refers to the technological development of nine digital industrial technologies (Atik and Ünlü, 2019). Despite the different definitions of the term, they all agree that it summarizes the technologies responsible for the automation of certain processes in the production or service industry (Hrbić and Grebenar, 2021). Business Digital Transformation aims to describe the intensive use of Industry 4.0, digital, technology, and resources with the goal of creating new ways of conducting business. Such organisations that were successful in implementing digital transformation often gained a competitive advantage and competitiveness in the market (Spremić, 2017). The EU has established robust industrial policies and principles that prioritize achieving industrial growth, increases in employment, and other objectives aligned with Industry 4.0 standards. As a member of the European Union, the Republic of Croatia must work towards realizing these industrial principles and policies (Tomljanović et al., 2019).

A study in 2019 (Juričević et al., 2020) was conducted to analyse two indexes related to digital transformation - Croatian Digital Index (HDI) (Apsolon, 2019) and the Digital Economy and Society Index (DESI) (European Commission, 2019). The analysis of the Human Development Index (HDI) indicated that a significant proportion of respondents (94%) believed that the absence of digital transformation would have a noteworthy impact on their organization's business. Nevertheless, just 47% of respondents put digital transformation among their top 10 objectives. Additionally, 15% of respondents had devised a digital transformation strategy, while 65% reported intending to develop one. The Croatian economy shows that it recognizes the value of digital transformation, but there is a lack of a strategy for its implementation. Existing business priorities, level of costs, and lack of time are the main reasons for the poor implementation rate (Tomljanović et al., 2019).

One of the most well-known ways to assess the digital transformation of European Union countries is DESI (European Commission, 2019). The five main dimensions of DESI, which are Connectivity, Human Capital, Use of Internet Services, Integration of Digital Technology, and Digital Public Services, were analysed and compared between EU countries. Croatia achieved the highest score in the dimensions, Use of Internet (11th) and Human Capital (18th), while being almost at the bottom in Connectivity (27th), Integration of Digital Technology (21st), and Digital Public Services (25th), showing that those categories related to potential (Human Capital and Use of Internet Services) are sufficient, but the implementation is yet to achieve its full capability (European Commission, 2019).

The latest study from Apsolon Consulting Company (Apsolon, 2021), analysing HDI for the year 2021, stated that the digitalisation of the Croatian economy in 2021 was evaluated with an average grade of 2.59, which was a slight increase compared to 2020 when it was graded 2.52. The same conclusion was made for the digitalisation of public services in Croatia,
which was graded with an average grade of 2.78 (2021), only a slight increase from the year before at 2.73 (2020).

Despite the positive trends noticed, the overall HDI score is not at a satisfactory level. There is sufficient room for improvement. But given the low growth rate of both the Digitalisation of the Croatian Economy and Public Services, there is a possibility of stagnation in these areas (Apsolon, 2021).

1.2 EU funded projects

Research and innovation have proven to be one of the most powerful European policies used to increase the economies and competitiveness of the Union, and as such, it is an engine of green and digital transformation on the continent (European Commission, 2020). In the next years, the EU’s key research and innovation funding programme, Horizon Europe, will have a budget of € 95.5 billion. The mentioned programme has the following main objectives – European Green Deal, Europe fit for the digital age, An Economy that works for people, Promoting our European way of life, A stronger Europe in the world, A New push for European Democracy, and a Modern, High performing and sustainable European Commission (European Commission, 2020). The European Innovation Scoreboard showed that the Republic of Croatia, part of the Emerging innovators group, between 2014 and 2021 improved by 21.5%, while the performance of the EU improved at a slower rate, by 12.5% points (European Commission, 2021).

The National Strategy for the stimulus of innovation of the Republic of Croatia from 2014 – 2020 for some of the main objectives had (1) investment in research at 1.4% of GDP, (2) investment of the business sector in research and development activities at 0.7% of GDP, (3) direct 33% of total investments in scientific research to investment projects, (4) increasing the number of patent applications per million inhabitants, (5) 25% of the contribution of foreign investors to investment in the business sector, (6) increasing the number of researchers in the total number of employees in the economy to 1,571 (Ministry of Economy, Entrepreneurship and Crafts of the Republic of Croatia, 2014).

The data found in 2019 show that in the last 10 years, the percentage of GDB invested in Innovation and Research activities was less than 1% and, for the first time in 2019, surpassed that number (Government of Republic of Croatia, 2019). Concrete investments in Innovation and Research projects for the past five years go as follows: €343.5 mill. (2016), €354 mill. (2017), €395.2 mill. (2018), €422.4 mill. (2019), €393.3 mill. (2020) (Eurostat, 2022).

In the last programming period of 2014 – 2020, the top three EU-funded Research and Innovation projects in Croatia were (European Commission, 2022) (1) Open Science Infrastructure Platforms for Innovative Applications in the Economy and Society - O-ZIP with a budget of 71,136 million. €, (2) Child centre for the translational medicine (CCTM) with a budget of 56,183 mil. €, and (3) Centre for research and education in medical ecology and radiation protection- Institute for Medical Research and Occupational Health in Zagreb, with a total budget of 30,238 million. €.
1.3 Managing EU funded projects

EU-funded projects, by their nature, do not differ from any other type of projects, and as such are present in every economic sector (private, public, and non-profit sectors). Projects are mostly implemented on a national level but can also be implemented on an international level (Gareis, 2005). EU projects respect the project life cycle and go through the following phases – initiating, planning, executing, monitoring, and controlling, and closing (Project Management Institute, 2004) (Association of Project Management, 2006) (Hermarij, 2016).

The instructions and methodological guidelines offered by EU fund providers provide a high-level overview of project management methods. However, they do not constitute a recommended or mandatory part of the terms and conditions governing project implementation, with the exception of the pre-project study stage. Given that there is no known standard of project management implementation when it comes to EU-funded projects, a study conducted in the Czech Republic in 2017 tried to analyse project management methods used in such projects (Kostalova et al., 2017), the results of which stated that 60.1% of the respondents use a single project management methodology (determined on the company level) when it comes to EU-funded projects, while 42.1% of the respondents use a single project management methodology when it comes to general project application. Since EU projects are subjected to an extensive system of rules, the results are not surprising; thus, conducting such research that would describe the overall EU project process to define a known standard of Project Management practice is justified (Kostalova et al., 2017).

1.4 Digital transformation of project management

A heat map, in general, is a visualization technique where certain values correspond to a specific colour to form a diagram where colour represents the intensity of the named measurement. Heat maps found their application in the optimization of business processes in order to eliminate wasteful work in various examples so far.

Recent studies (Tomanek and Schröder, 2017) show that The Value-Added Heat Mapp found its use for space usage problems, machinery utilisation, and intralogistics traffic load. However, its last application was on the assessment of information flow (Tomanek et al., 2020), namely, detecting that defective and incomplete information can be the cause of non-value-added work. This method is also used to determine the degree of digitalisation for information flow in manufacturing companies (Tomanek et al., 2020).

One of the methods used to improve organisational performance is maturity models, which help organisations achieve the expected skills in specific dimensions with the use of a continuous improvement approach (Jesus, 2020). A study (Gökalp et al., 2017) reviewed the literature and found seven relevant industry 4.0 maturity models, which were then subjected to an assessment test. The results showed that none of the maturity models satisfied all the criteria and that they need to be further improved. The issue was found to stem from the absence of a widely accepted framework for evaluation and improvement, as well as a well-defined structure consisting of established practices, inputs, and outputs. (Gökalp et al.,
2017). A study reached a similar conclusion (Carolis et al., 2017), highlighting that the vast majority of published Maturity Models lacked a solid theoretical foundation and methodology. Moreover, there is limited documentation available on how to develop such a foundation. In 2021, a conference paper (Sebastian, 2021) was published on a topic stating 'to date, no suitable maturity assessment model has been identified in the literature.' Therefore, we wanted to come up with an approach that sets up a baseline for digital maturity assessment of any business process, which is shown in this paper.

In the next sections, the methodology used to collect data and create digitalisation heat maps is demonstrated. In the third section, we explain the results collected and quantitatively analyse the flow chart. The last section discusses the next steps for future research into this area.

2. METHODS

The first step in the creation of the digitalisation heat map was to review the available literature on project management, R&D investments, and digital transformation. The goal of literature review was to find supporting data on research and development investments and comparison of Croatia with the region and the world in the context of digital transformation and project management methodologies. The literature review incorporated relevant keywords, including 'Project', 'Management', 'Digital Transformation', 'Croatia', 'R&D', 'EU Funding', and 'Industry 4.0' searched across Scopus, Web of Science, and Google Scholar databases. Any essential data that could not be obtained through scientific literature were extracted from other publicly available sources: Eurostat, the official webpage of the European Commission, and the Croatian Ministry of Economy. Literature search was first done by searching papers using keywords and their combinations (e.g. EU Project Management, Digitalization of Project Management, EU Funded R&D projects), resulting in finding 811 papers related to the topic. To narrow the search even more, screening the papers by name and topic relevance was the next step, so 70 papers were selected based on those criteria. Reading the abstracts of selected papers, research team focused on 20 papers for which they believe that are the most relevant for this specific research case. Later, the literature review was done based on those papers.

Members of the research committee conducted an interview with the experienced EU funds consultant who gave us details on the project management. The process was selected from a specific EU funding program to strengthen the competitiveness and capacity of small and medium-sized enterprises. Interview, and later the research itself, was based on a single EU Funded R&D project that has all the characteristics of a common Research and Development project to be able to adequately represent the whole R&D EU-financed project group. The project in question was successfully finished before this research started. The results collected from the EU consultant were structured in a table with the following columns: (1) Name of the activity, (2) Activity type, (3) Activity stakeholder, (4) Information flow level (5) Confidence level.
The next step was to develop a flow chart diagram to visualize the process flow and show the information exchange between the process stakeholders. The flow chart consisted of five stakeholders – Managing Institution (Ministry of Regional Development and EU Funds), Level 1 Intermediate Institution (Ministry which is publishing tender), Level 2 Intermediate Institution (Hamag BICRO or Central Financing and Contracting Agency), EU funds consultant, and Project Applicant (Ltd.). All the above-mentioned stakeholders were involved in every project phase and are by law mandatory stakeholders of national EU-funded R&D SME to strengthen their competitiveness and the capacity. The only one that change from project to project are the project applicant and the EU funds consultant.

Given the known standards of process mapping, we used standard process symbols to map typical EU funded R&D projects - rectangle (activity), triangle (evaluation), rhombus (decision), round rectangle (process start/end), paper icon (documentation).

Afterwards, to transform a standard flow chart diagram into a digitalization heat map, it was necessary to evaluate each process step using the Evaluation Scale for Information Flow defined in the research paper (Tomanek and Schröder, 2017). In addition to the scale, we stated our confidence level for each process step and its Information Flow level. The evaluation scale for information flow (Tomanek and Schröder, 2017) had 6 levels defining Value Added Levels of Information exchange, Level 0 being with no Added Value to the process and Level 5 being Maximum Added Value, going as follows: (0) Insufficient, incorrect, or unnecessary exchange of information, (1) Written exchange of information (e.g. paper document, fax, e-mail, etc.), (2) Verbal or visual exchange of information, (3) Electronical exchange of information not real-time (e.g. by spreadsheet application), (4) Electronical exchange of information real-time (e.g. by system-application), (5) Digital exchange of information real-time (e.g. by Internet of Things and Service).

Corresponding colours, for Heat Map development, matching the Information Flow Levels are as follows: (1) Level 0 – Purple, (2) Level 1 – Blue, (3) Level 2 – Green, (4) Level 3 – Yellow, (5) Level 4 – Orange, (6) Level 5 – Red.
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The confidence level was defined in 4 levels: (1) No information or findings, (2) Assuming, No first-hand information, (3) Assessment based on findings, (4) First-hand information.

The final step of the research was to perform a quantitative analysis of the Digitalisation Heat Map, focusing mainly on information exchange between the stakeholders in the process. Each stakeholder was analysed separately, and the results were presented via charts.

3. RESULTS AND DISCUSSION

3.1 Structuring flow chart

The flow chart (Digitalisation Heat Map) had 47 process steps (Activity – 22, Evaluation – 11, Decision – 14) implemented within 5 stakeholders. The dispersion of the process steps in percentages can be seen in Figure 2, showing that the activity and evaluation process steps comprised 70% of all the process steps.
Figure 4. Structured flow chart – Heat map 3/6

Figure 5. Structured flow chart – Heat map 4/6
Figure 6. Structured flow chart – Heat map 5/6

Figure 7. Structured flow chart – Heat map 6/6
Figure 8. EU R&D project – Process steps overview

The project applicant was the stakeholder with most of the activity process steps (11) and was also responsible for the creation of 58.3% of all documentation that occurred in the project. It is interesting to note that 54.5% of all activity process steps resulted in the creation of documentation.

The EU fund consultant was responsible for 7 process steps (6 – Activity, 1 – Evaluation). Furthermore, the Project Applicant & EU fund consultant combined were responsible for 77.3% of all activity process steps, which confirms their role in the process as stakeholders responsible for preparatory actions and creation of the following documentation. However, Level 1 & Level 2 Intermediate Institutions were responsible for evaluating the created project documentation and deciding if the project will go on. To confirm the fact, 81.8% of the evaluation and 85.7% of the decision process steps were done by these stakeholders. The managing institution (Ministry) was the only stakeholder with the least number of process steps (3; Activity – 1, Evaluation – 1, Decision – 1), and is included only in complaint procedures.
3.2 Digitalisation levels of activities

The information flow levels of the process can best be described as shown in Figure 9.

Figure 9 shows that no single process step was evaluated with Level 0 (*Insufficient, incorrect or unnecessary exchange of information*) or Level 5 (*Digital exchange of information in real-time*), which indicates that neither no value-added or maximum value-added exchange of information was present in the process, according to our knowledge. Furthermore, it was interesting to note high dispersion in the exchange of information. Information exchange was done either in written form (Level 1) or electronically in real-time (Level 4), marking those two as extremes of the exchange process.

Process stakeholders had different roles in the process of EU-funded R&D projects, so the information exchange within and between them needed to be analysed.
The information exchange of the project applicant, as seen in Figure 10 when we discuss the information exchange with the intermediate level institution (Hamag BICRO or Central Financing and Contracting Agency), was carried out electronically in real time (Level 4), referring to the project applicant's responsibility to submit valid project documentation.

The exchange of information between the Project Applicant & EU Funds Consultant was written (Level 1) or verbal/visual (Level 2), which was expected since the information exchange took place through conference calls, meetings, or other forms of verbal/visual communication, as shown in Figure 11.

Level 2 Intermediate Institution, shown on Figure 12, was mostly engaged in the application and realisation part of the process, serving as a link between Project Applicant and Level 1
Intermediate Institution. Exchange of information with Project Applicant was concentrated on sending feedback (Level 4) about the progress of Project Application, and later on in the realisation phase about evaluating (Level 1) and approving (Level 4) procurement plan, Applications for Reimbursement, and Project Reports.

Figure 12. Information flow/digitalisation level – Level 2 Intermediate Institution

Figure 13. Information flow/digitalisation level – Level 1 Intermediate Institution

Figure 13 shows that the exchange of information of Level 1 Intermediate Institution, Level 3, and Level 4 refer to information exchange with Project Applicant and Level 2 Intermediate Institution. But all the information exchange with the stakeholder (Level 1 intermediate Institution) was done with Level 1 Information flow. The stakeholder was involved in the following process steps: (1) Evaluation & Decision of project quality, (2) Evaluation &
Acceptance of project expenses, (3) decision about Project Financing & Preparation of financing agreement, (4) evaluation of project participation, and (5) contract signing.

Figure 14. Information flow/digitalisation level – Managing Institution

The managing institution, the stakeholder with the least process steps, was only involved in the complaint evaluation process. The exchange of information in the process is done by mail, which is shown in Figure 14.

Finally, it is important to say that the confidence level for all steps of the process is evaluated with the highest grade (Level 4). The data were interpreted by an experienced EU project consultant familiar with the procedures within all stakeholders of the project, which means that authors can, with great certainty, consider the estimated degrees of digitisation reliable and accurate.

4. CONCLUSION

In this paper, we have successfully shown a novel approach for evaluation of the digital maturity level of business process activities. The usability of this approach was demonstrated by mapping the process of EU-funded R&D projects involving five different stakeholders, analysing the level of digitalisation of each activity, and illustrating the potential for digitalisation of different stakeholders. The research results highlight the further potential of digital transformation of process activities, especially in the domain of Managing Institution and Level 1 Intermediate Institution. Our study provides the foundation for a new way of human-friendly mapping of processes by implementing heat maps, which gives decision makers a high-level view of the project management process, indicates potential for improvement and digitisation, and results in higher efficiency and productivity of processes.
More research should address in-depth communication between EU consultants and project applicants, especially for activities that occur when EU consultants are preparing a procurement plan as well as an application for reimbursement. Furthermore, we suggest that

Future research should examine extraordinary circumstances that result in changes of lesser or greater significance to the project and their implications on project lead times. In the end, we suggest future research by comparing the degree of digitisation in different types of projects.

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