DIG-IN-KPI: Project: 2nd phase report

EVALUATION AND COMMENT ON THE RESULTS OBTAINED IN THE WEB APPLICATION DIG-IN-KPI-AAT

Co-funded by the European Union

DIG-IN-KPI

СТОПАНСКА КОМОРА НА СЕВЕРНА МАКЕДОНИЈА
ECONOMIC CHAMBER OF NORTH MACEDONIA

Gospodarska zbornica Slovenije
Chamber of Commerce and Industry of Slovenia

Chamber of Construction and Building Materials Industry of Slovenia

HGK 1852
CROATIAN CHAMBER OF ECONOMY

DIG - IN - KPI

Digital transformation is making its way into businesses - developing key performance indicators to boost sector productivity

PHASE NO. 2

RESULT NO.: R5
Evaluation and comment on the results obtained in the web application DIG-IN-KPI-AAT

May 2024, modified June 2024

Authors: DIG-IN-KPI team from Slovenia
Darja Močnik, Valentina Kuzma, Gregor Ficko and Mirko Troha

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Kazalo vsebine

INTRODUCTION 3
MONITORED INDICATORS AND GROUPS 3
RESEARCH PROCESS 4
ANALYSIS OF EVALUTION RESULTS IN SHORT 6
ANALYSIS OF EVALUTION RESULTS IN DETAIL 8
FUTURE PLANS AND NEXT STEPS 17
NEXT STEPS 17
IMPACT AND DATA UTILIZATION 17
RECOMMENDATIONS 18
ANNEX 19

INTRODUCTION

The DIG-IN-KPI project, funded under the Erasmus+ KA210-VET program, aimed to boost digital transformation in the construction sector by developing and implementing key performance indicators (KPIs). The project involved partners from Slovenia, Croatia, and North Macedonia.

Digital transformation is becoming a cornerstone for maintaining competitiveness, increasing productivity and promoting innovation in companies in various sectors. The DIG-IN-KPI project, funded under the Erasmus+ KA210-VET programme, is a concerted action to promote digital transformation in the construction industry through the development and implementation of key performance indicators (KPIs). This initiative brings together partners from Slovenia, Croatia and North Macedonia and aims to bridge the digital maturity gap within the sector.

The construction industry, traditionally known for its slow adoption of digital technologies, stands to benefit significantly from enhanced digital strategies. The DIG-IN-KPI project addresses this by creating a robust framework for assessing digital maturity and providing tailored recommendations for improvement. The DIG-IN-KPI project has been a significant endeavor in promoting digital transformation within the construction sector. One of the critical outputs of this project is the DIG-IN-KPI AAT tool, dig-in-kpi.aat4.eu, designed to assess and enhance the digital maturity of construction companies and educational institutions.

The technical basis of this tool is based on the award-winning automated assessment tool (AAT) developed and improved by Arctur d.o.o., a company based in Nova Gorica, Slovenia, for the purposes of DIG-IN-KPI.

This report R5, marking the second phase of the DIG-IN-KPI project, provides a comprehensive evaluation and commentary on the results obtained through the online application of the DIG-IN-KPI AAT tool. The tool's multi-language support has enabled extensive participation, yielding a diverse dataset for analysis from the involved countries.

MONITORED INDICATORS AND GROUPS

The indicators are divided into several key areas:

1. **Digital transformation**
2. **Project management**
3. **Bill of quantities**
4. **Financial evaluation**
5. **Time scheduling**
6. **Billing of construction works**
7. **Financial and time monitoring of the project**
8. **Business management**

RESEARCH PROCESS

The R5 research phase of the DIG-IN-KPI project took place from March 2024 to May 2024 across the three project countries: Slovenia, Croatia, and North Macedonia and via FIEC network and media to reach other EU countries. This phase involved inviting organizations and companies to participate in the assessment of their digital maturity using the DIG-IN-KPI AAT tool. The research process was structured to ensure comprehensive data collection and engagement with a diverse range of participants in the construction sector.

Invitation and Outreach

To maximize participation, we employed a multi-channel communication strategy, including:

1. **E-mail invitations:** Personalized email invitations were sent to a curated list of construction companies and educational institutions. These emails contained detailed information about the project, the purpose of the research, and instructions on how to access and use the DIG-IN-KPI AAT tool.
2. **Social media campaigns:** We launched targeted campaigns on social media platforms such as LinkedIn, Facebook, and Twitter. These campaigns included posts, infographics, and short videos explaining the benefits of participating in the research and how to get involved.
3. **Final conference:** We organized final conference to present the DIG-IN-KPI AAT tool, demonstrate its use, and answer any questions from potential participants. These sessions were recorded and made available on our project website for later viewing.
4. **Industry conferences and events:** Information about the research was shared at relevant industry conferences and events. Flyers and brochures were distributed, and a dedicated booth was set up at select events to provide in-person assistance and answer queries.
5. **Partnerships with industry associations:** We partnered with various construction industry and professional associations and chambers of commerce and regional organization in the three countries. These partners helped disseminate information through their networks, newsletters, and official websites.

Data Collection and Challenges

Despite the extensive outreach efforts, the research phase encountered several challenges:

1. **Incomplete responses:** A significant number of participants did not fully complete the assessment. This was often due to the length of the questionnaire and the detailed nature of the indicators. Some participants started the assessment but did not finish it, possibly due to time constraints or difficulty in gathering the required data.
2. **Delayed responses:** Many organizations took longer than anticipated to complete the assessment. This delay was often because participants needed to consult with various departments within their organizations to gather accurate data for the indicators.
3. **Technical issues:** Some participants experienced technical difficulties accessing and navigating the DIG-IN-KPI AAT tool. Although we provided technical support through email and via telephone (by ARTCUR) chat, these issues still caused delays and frustration among users.
4. **Awareness and Engagement:** Despite our outreach efforts, some potential participants were unaware of the research or did not see the relevance of the assessment to their operations. This limited the overall response rate.

Mitigation Strategies

To address these challenges, we implemented several mitigation strategies:

1. **Follow-up communications:** We sent several reminder emails and made follow-up phone calls to encourage participants to complete the assessment. These communications emphasized the importance of their input and how it would benefit their organization and the broader construction sector.
2. **Simplified instructions:** We revised the instructions provided with the assessment to make them clearer and more concise..
3. **Extended deadlines:** Recognizing the difficulties participants faced in gathering data, we extended the deadline for completing the assessment. This extension allowed more organizations to participate fully.
4. **Enhanced technical support:** We increased the availability of our technical support team (ARCTUR) and provided additional resources, such as video tutorials and troubleshooting guides, to assist participants in navigating the DIG-IN-KPI AAT tool.

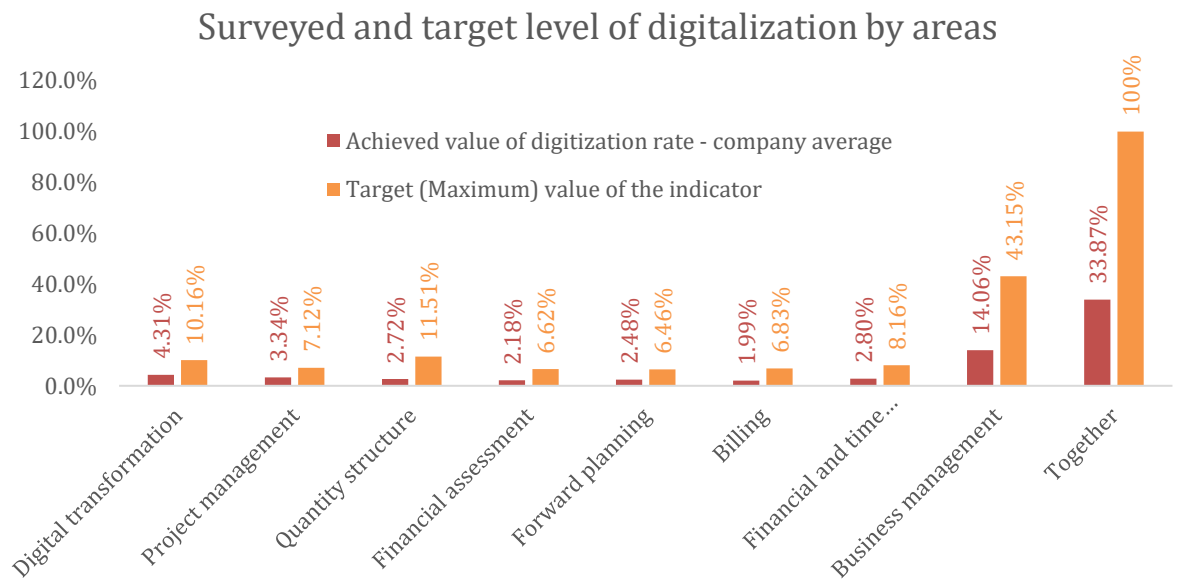
Despite these above listed challenges, the research phase successfully gathered valuable data from a diverse group of construction companies and educational institutions. This data will contribute significantly to our understanding of digital maturity in the construction sector and inform future digital transformation strategies.

ANALYSIS OF EVALUTION RESULTS IN SHORT

Average value: 33.87%, Target: 100%

Commentary: **The overall average digitalization rate in all 3 project countries for all areas is 33.87%, indicating that digitalization in construction companies is still at a low level (digitization only). This clearly shows that a comprehensive strategy is needed to improve the situation!**

Based on the data collected through the DIG-IN-KPI AAT tool, several insights and trends have emerged. The tool's multi-language support enabled participation from Slovenia, Croatia, and North Macedonia, providing a diverse dataset for analysis.



The most important results of the DIG IN KPI collected with the tool are:

Digital Maturity Levels:

- Overall digital maturity: the average digital maturity level of participating companies indicates **a moderate level of digital adoption, with significant room for improvement in certain areas.** The data shows that while some companies have introduced digital tools, many are still operating at a lower level of digital maturity.
- Country-specific trends: C**ompanies in Slovenia have a relatively higher level of digital maturity than companies in Croatia and North Macedonia**. This discrepancy highlights the need for targeted support and resources in less developed regions.

Key Performance Indicators (KPIs):

- **Training and Skills Development:** There is a notable gap in digital skills and employee training. Many companies expressed the need for better training programs to improve the digital skills of their employees. Addressing this gap is essential for fostering a culture of

continuous improvement and ensuring that employees are well-equipped to utilize advanced digital tools effectively.

- **Use of Digital Tools:** The use of digital tools for project management, communication, and data analysis varies greatly among companies. Companies with a higher level of digital maturity tend to make extensive use of advanced tools such as Building Information Modelling (BIM) and project management software. These tools have been instrumental in improving project accuracy, efficiency, and overall performance.
- **Digital Transformation Strategy:** The implementation of a comprehensive digital transformation strategy remains a critical challenge. The data indicates that many companies are still in the early stages of developing and executing these strategies. A robust digital strategy is crucial for guiding organizations through the transition and ensuring sustained digital growth.
- **Interoperability and Data Integration:** There is a significant need for improving interoperability and data integration across various systems used by construction companies. The ability to seamlessly share and analyze data is fundamental to enhancing collaboration, reducing errors, and improving decision-making processes.
- **Adoption of BIM Standards:** While some companies have successfully integrated BIM standards, others lag behind. Promoting the adoption of BIM standards across all projects can lead to better project outcomes, reduced costs, and improved collaboration among stakeholders.

Barriers to Digital Transformation:

- Cost and resources: One of the main obstacles is the high cost of digital tools and the lack of resources to use them effectively. Smaller companies in particular could struggle with the financial burden if they want to actively and effectively implement digital transformation.
- Resistance to change: Resistance to change and a lack of digital skills among employees were also key barriers. This resistance is often due to a lack of understanding of the benefits of digital tools and fear of job losses.

Commentary on Results

The results obtained from the DIG-IN-KPI AAT tool provide valuable insights into the current state of digital maturity in the construction sector. However, it is important to note that the current sample size is relatively small. As the tool continues to be used, we anticipate gathering more comprehensive data that will provide a clearer picture of the sector's digital maturity.

Positive Aspects

- The tool has successfully identified key areas where construction companies – contractors can improve their digital maturity.
- It has provided personalised recommendations that companies and organisations can use to improve their digital maturity.
- The involvement of various stakeholders, including construction companies and educational institutions, has highlighted the importance of teaching digital skills in vocational education and training (VET).

Challenges and Limitations

- **Small sample size**: The small sample size limits the generalizability of the findings. As more companies and organization from more EU countries not just 3 project countries use the tool, the data will become more representative.
- **Continuous engagement needed:** There is a need for continuous engagement with companies and organizations to ensure they complete the assessment and implement the recommended changes.
- **Tool functionalites and set areas of indicators included:** Originally, consortium wanted to explore three additional areas: Construction Drawings, Interoperability and Artificial Intelligence, but due to financial constraints we were unable to fully realise these plans. During the development of the AAT software, it became apparent that managing 50 indicators perhaps would be too cumbersome and time-consuming for persons exploting DIG IN KPI AAT tool.

ANALYSIS OF EVALUTION RESULTS IN DETAIL

In this analysis, we will look at how the level of digitisation varied among 17 construction companies from three countries: Slovenia, Croatia and North Macedonia. 3 companies had a digitisation level of up to 10%, and 4 companies had a digitisation level of between 16% and 20%, 7 companies between 32% and 45%. 3 companies had a digitisation level of over 50%, which means that they have already made a big step in this area. Thus, one company had a digitisation rate of 58%, one 76% and the best company 81%.

The **top three digitised construction companies (digitisation rate between 58% and 81%)** use different tools and software to optimise their processes. Their strategic use of digital tools spans across multiple aspects of their operations, significantly enhancing efficiency and accuracy. Here are the key tools and their applications. They use Informatics, Management and IT in their digital transformation. At project work, they use XPERT - AXIS, ORKA - ORKA IT, POWER APPS - MICROSOFT - OWN DEVELOPMENT, KI, AutoCAD, Excel, and InfoMatrix. In the bills of quantities works use XPERT - AXIS, AUER, Excel and InfoMatrix, in financial evaluation XPERT - AXIS, ABK8, AUER and InfoMatrix. Scheduling includes MS Project, XPERT - AXIS and InfoMatrix. For billing and monitoring, they use XPERT - AXIS, AUER, Word and InfoMatrix, while the business part is supported by ORKA ERP, e-commerce, Excel and InfoMatrix. These tools allow companies to improve efficiency, accurate tracking of resources and costs, and better communication in projects, contributing to their high level of digitalisation.

Seven of the **construction companies surveyed with a digitisation rate between 32% and 45%** are using a variety of tools and software to optimise their processes. At digital transformation, companies are focusing on strategies such as project department, administration, director and engineering, with project work use tools such as STAS Organiser, Qnap server, MS Office, BLIST, One Drive, Microsoft 365, Construction eLog, and Procore. The project work is carried out using MS Excel, MS Office, BLIST and ArchiCAD, BIM Vision while bills of quantities are managed using BLIST, standardised inventory databases and MS Excel. The financial evaluation is based on the use of tools such as MS Excel and BLIST, while scheduling includes MS Project, BLIST and Project oriented solutions. MS Excel, BLIST and specific accounting tools. Financial and time monitoring of projects is done through MS Excel, MS Office and BLIST. Business information systems include Minimax, STAS Organiser, MS Office and tools for

resource tracking, resource procurement and warehouse management. The companies rely on a combination of basic office tools and specialised software, enabling them to to implement projects efficiently and track their objectives.

The surveyed companies in the construction sector, where the **digitisation rate ranged from** 0-20%, use a variety of tools and technologies. Most companies do not have specific digitisation strategies or a digital culture. They use a variety of tools such as Excel, Dropbox and Microsoft Office. Some companies carry out projects using BIM (Building Information Management) technology or Microsoft Project. Bills of quantities of works are carried out in Excel. Some companies use costing sources and norms for the financial evaluation of projects. Scheduling is done in Excel. Subcontractors are invoiced using construction situations. For financial and scheduling monitoring of projects, they use various tools such as Excel, Word, Pdf and local server databases. In the business area, they deal with information systems, e-commerce and master codebooks.

More precise classification of the DIG IN KPI classification of the most important KPI indicators for constructions are presentation in continuation.

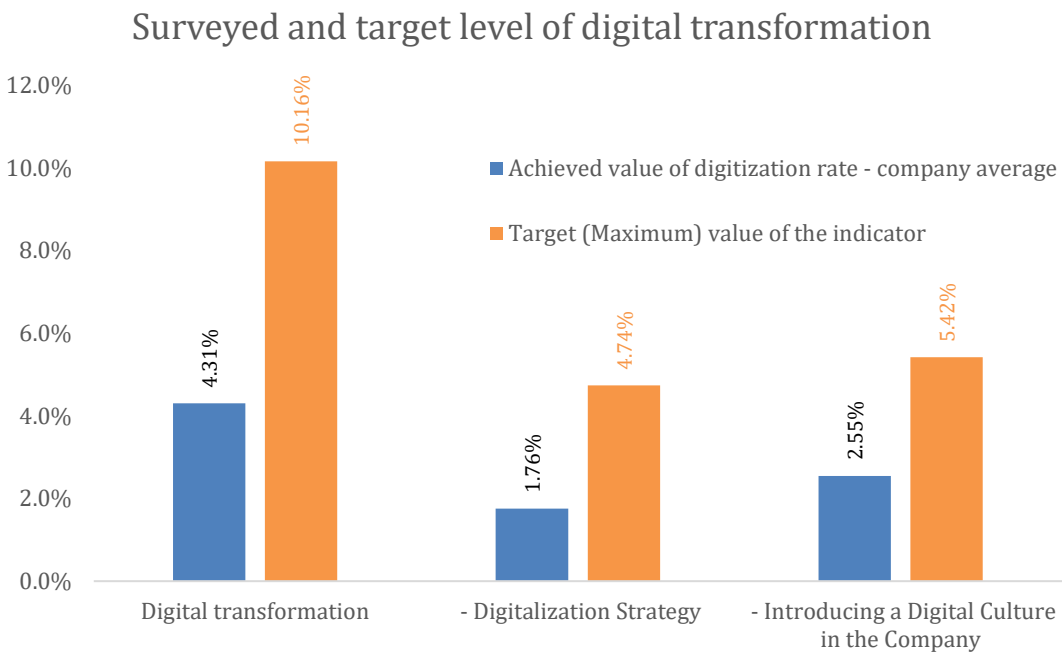
The indicators of the digitisation rate areas of the construction industry are presented in more detail in tabular form.

	Achieved value of digitization rate - company average	**Target (Maximum) value of fields and indicator**	**Achieved according to the target in %**
Digital transformation	4.31%	**10.16%**	42.39%
- Digitalization Strategy	1.76%	**4.74%**	37.06%
- Introducing a Digital Culture in the Company	2.55%	**5.42%**	47.06%
Project Management	3.34%	**7.12%**	46.86%
- Project Information System	1.58%	**2.95%**	53.53%
- Project Information System	0.91%	**1.72%**	52.94%
- Web Portal and Common Data Environment	0.74%	**1.85%**	40.00%
- Construction Diary	0.11%	**0.60%**	17.65%
Quantity structure	2.72%	**11.51%**	23.60%
- Format of the Priced Bill of Quantities	0.51%	**1.23%**	41.18%
- Text Description of Works in BoQ Item	0.74%	**3.08%**	24.12%
- Quantity for BoQ Item	0.74%	**3.08%**	24.12%
- Making of BoQ	0.42%	**1.66%**	25.29%
- Contractor's Lots	0.30%	**2.46%**	12.35%
Financial evaluation	2.18%	**6.62%**	32.91%
- Calculative Resources	0.72%	**2.46%**	29.41%
- Construction Calculation and Database for Resource Consumption Rates	0.96%	**2.46%**	38.82%
- Database of Past Project BoQ Items	0.50%	**1.69%**	29.41%
Term Scheduling	2.48%	**6.46%**	38.38%
- Time Schedule	1.52%	**2.46%**	61.76%

- Linking BoQ Items and Activities in the Time Schedule	0.87%	**2.46%**	35.29%
- Linking Elements from the BIM Model and Activities from the Time Schedule	0.09%	**1.54%**	5.88%
Billing od Construction Works	1.99%	**6.83%**	29.13%
- Calculation of Monthly Situations (Billing Quantities)	0.41%	**1.85%**	22.35%
- Accounting for Co-contractors and Sub-contractors	0.41%	**1.66%**	24.71%
- Change Management	0.50%	**1.48%**	34.12%
- Construction Measurement Book (Quantities Executed	0.66%	**1.85%**	35.88%
Financial and Time Monitoring of the Project	2.80%	**8.16%**	34.29%
- Project Performance	0.45%	**1.48%**	30.59%
- Tracking Activities in the Time Schedule	0.45%	**1.72%**	25.88%
- Comparison of Planned and Actual Consumption by Quantity and Cost According to Production Resources	0.51%	**1.08%**	47.06%
- Comparison of Planned and Actual Use of Resources per BoQ Item (Work Orders)	0.44%	**1.08%**	41.18%
- Comparison of the Planned and Actual Use of Resources for Each Activity in the Time Schedule (Work Task)	0.38%	**1.08%**	35.29%
- Project Progress Report	0.57%	**1.72%**	32.94%
Business Management	14.06%	**43.15%**	32.60%
- Business Information System	2.59%	**6.77%**	38.24%
- E-commerce	1.99%	**6.77%**	29.41%
- Master Data Code for Workers, Vehicles, Machinery, and Equipment	2.71%	**6.77%**	40.00%
- Real Resources	1.72%	**5.85%**	29.41%
- Commercial Resources	0.67%	**2.59%**	25.88%
- Worker's Status by Worksite	0.51%	**2.22%**	22.94%
- Vehicle and Machine Tracking (Sensors and Remote Reading)	0.29%	**0.92%**	31.18%
- Work Orders	0.64%	**1.94%**	32.94%
- Establishing Production Resource Requirements	0.65%	**2.22%**	29.41%
- Procurement of Production Resources	0.82%	**2.49%**	32.94%
- Tendering Procedure for Subcontractors	0.58%	**2.46%**	23.53%
- Storage Management	0.90%	**2.15%**	41.76%
Together	33.87%	**100%**	33.87%

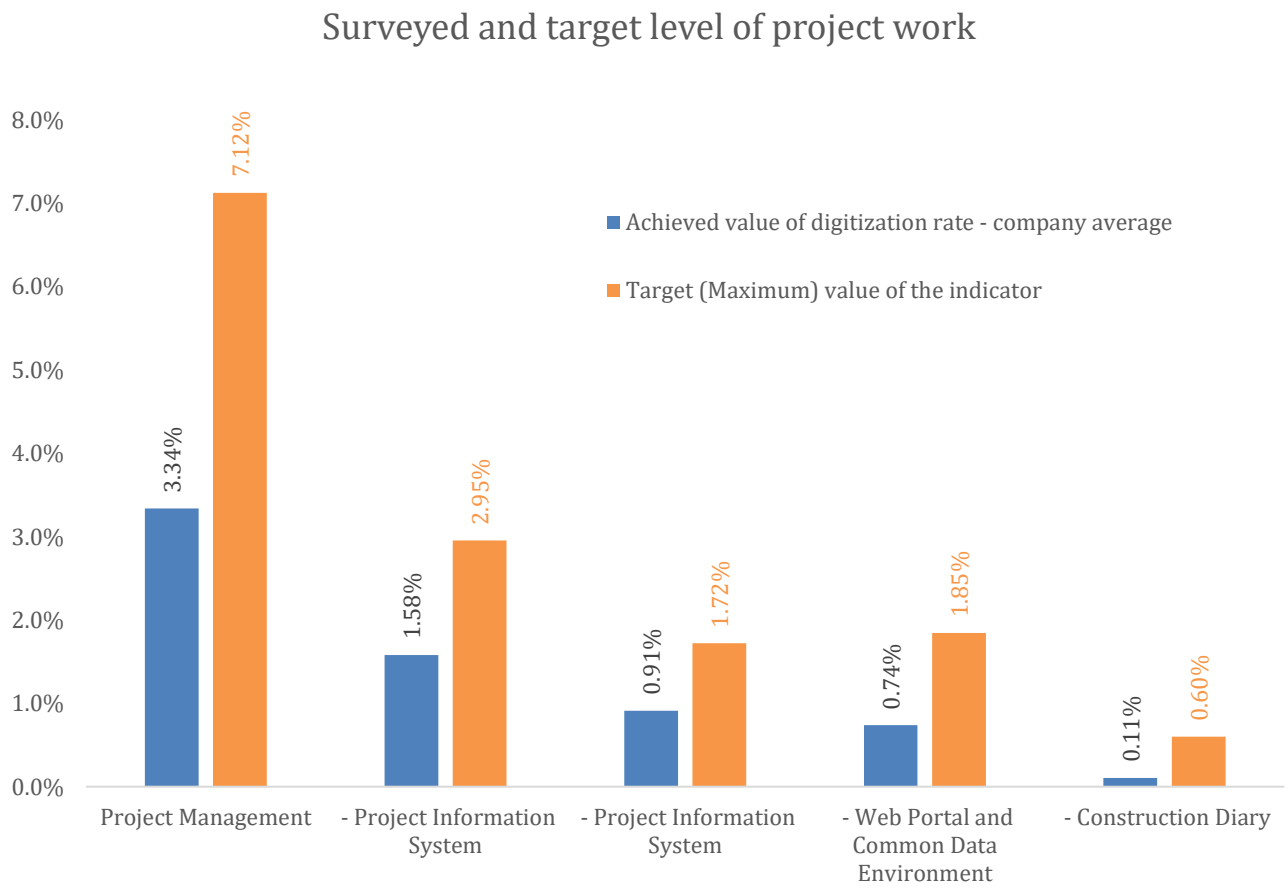
Digital Transformation Average value: 4.31%

- **Target:** 10.16%
- **Commentary:** The average digitisation rate for digital transformation in construction companies is 4.31%, less than half of the target. This suggests that most companies have not yet reached a sufficient level of digital transformation, which could affect their long-term competitiveness. Significant efforts are required to implement digital strategies and foster a digital culture within organizations.



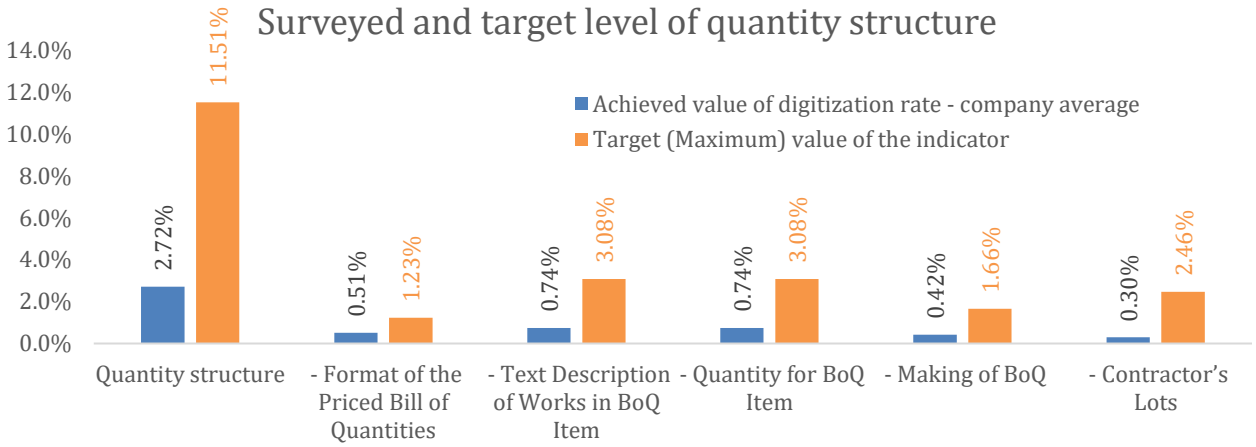
Project Management

- **Average value:** 3.34%
- **Target:** 7.12%
- **Commentary:** The project component achieves an average of 3.34%, less than half the target. This points to the need to improve digital tools and methods in the project phases, which could contribute to better efficiency and accuracy of projects. Enhancing digital project management systems and integrating them with other business processes could drive better project outcomes.



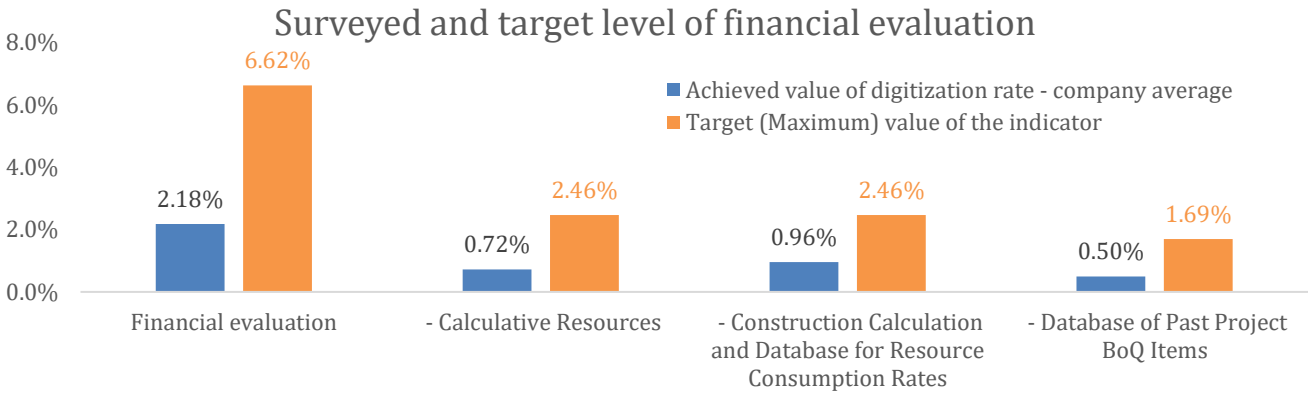
Bill of Quantities

- **Average value:** 2.72%
- **Target:** 11.51%
- **Commentary:** The bill of quantities area has an average digitisation rate of 2.72%, well below the target. This area has one of the largest gaps between the current situation and the target, indicating that significant improvements are needed in the digitisation of inventory processes. Automating the creation and management of bills of quantities could streamline project execution and reduce errors.



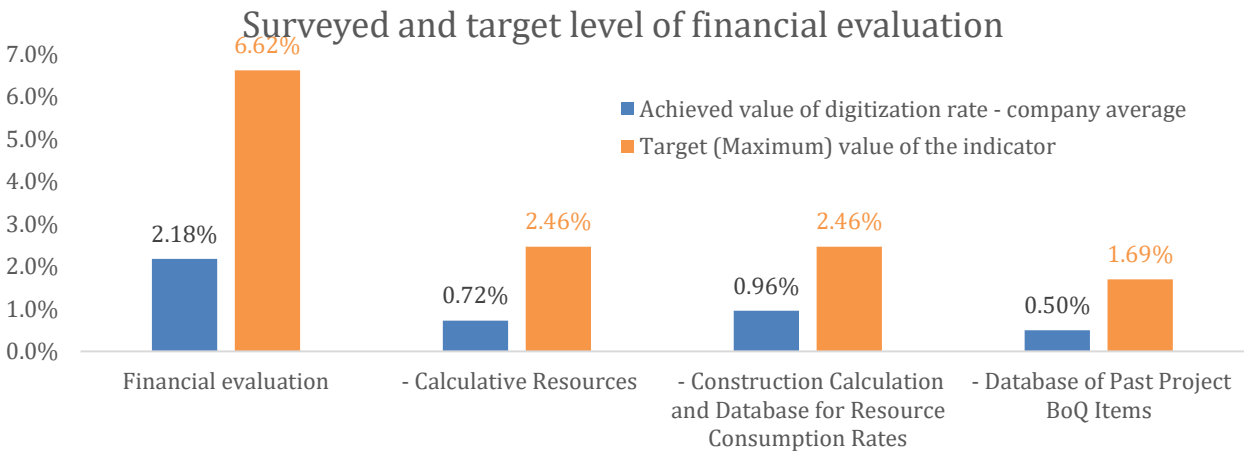
Financial Evaluation

- **Average value:** 2.18%
- **Target:** 6.62%
- **Commentary:** The financial evaluation averages 2.18%, less than a third of the target. This points to the need for better digital solutions to assess and evaluate the financial aspects of projects. Implementing advanced financial software could enhance accuracy in cost estimation and budgeting, leading to more financially sound projects.



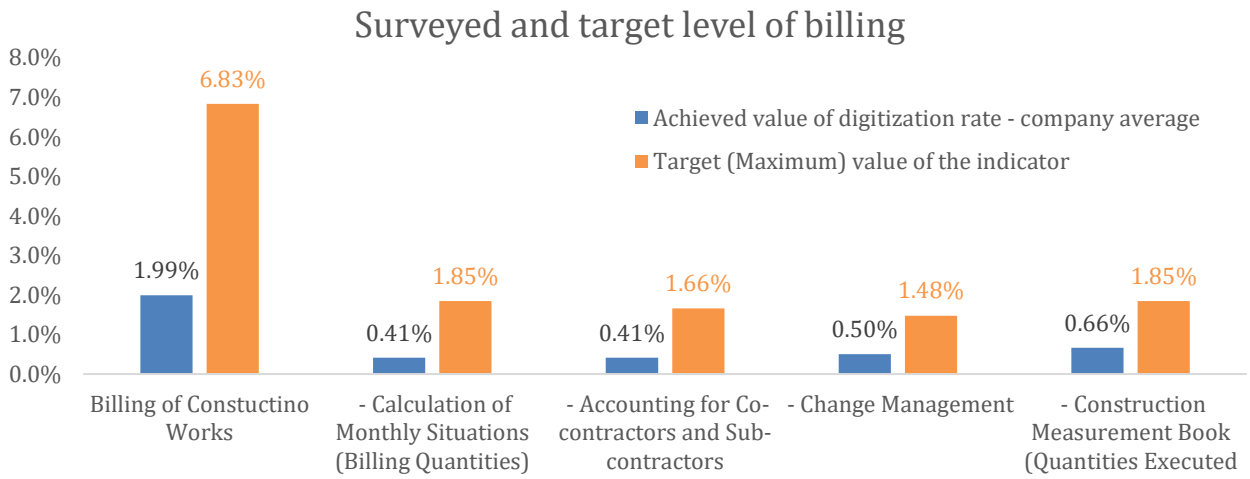
Time Scheduling

- **Average value:** 2.48%
- **Target:** 6.46%
- **Commentary:** Forward planning has an average value of 2.48%, which is also less than half of the target. Effective scheduling is key to successful project delivery, so it is important that companies improve their digital infrastructure in this area. Digital tools for project scheduling and resource allocation could improve overall project timelines and reduce del



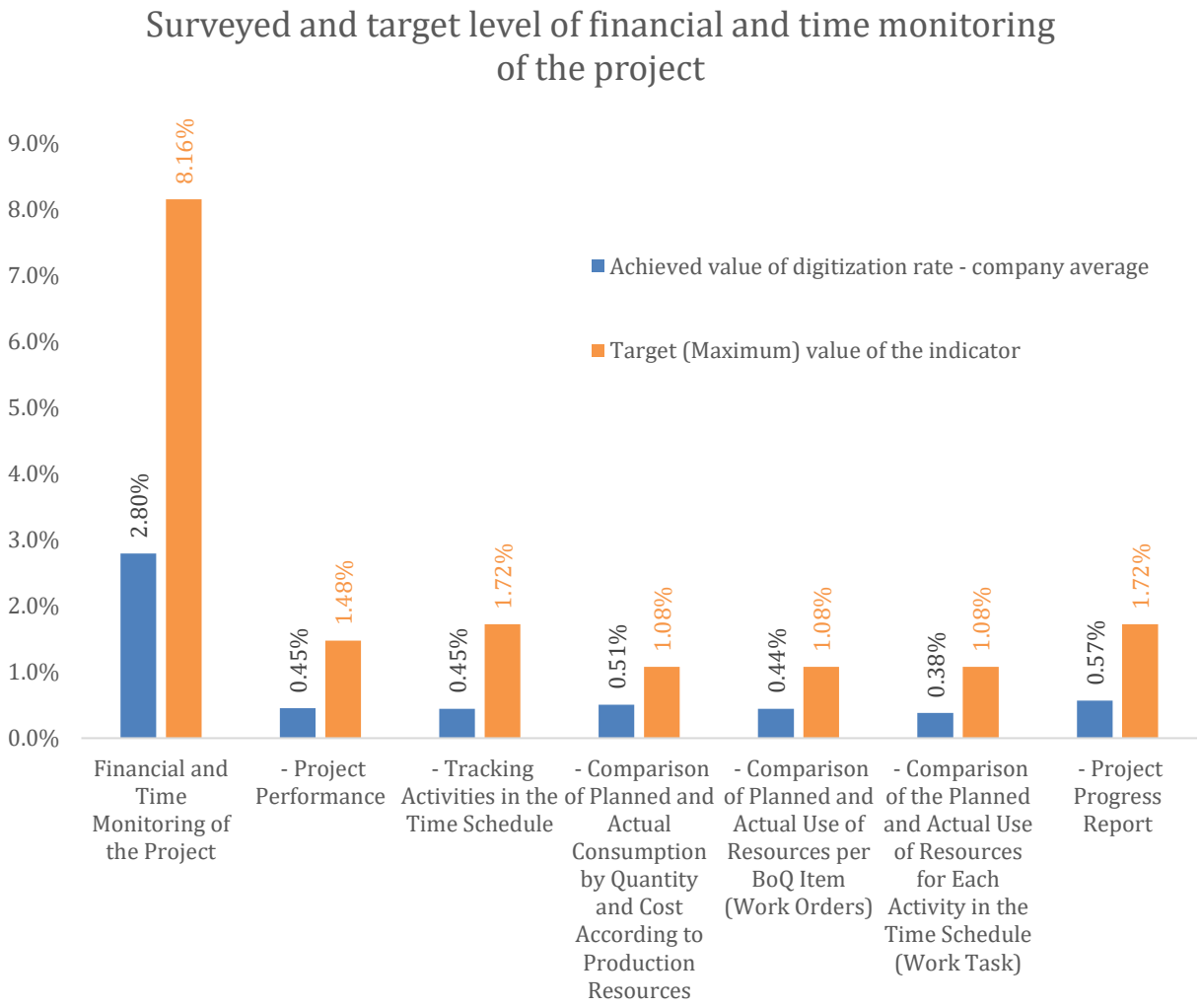
Billing of construction works

- **Average value:** 1.99%
- **Target:** 6.83%
- **Commentary:** The billing area achieves an average value of 1.99%, less than a third of the target. This means that further attention is needed in digitising billing processes to achieve greater accuracy and efficiency. Adopting digital billing systems can reduce errors, improve cash flow, and ensure timely payments.



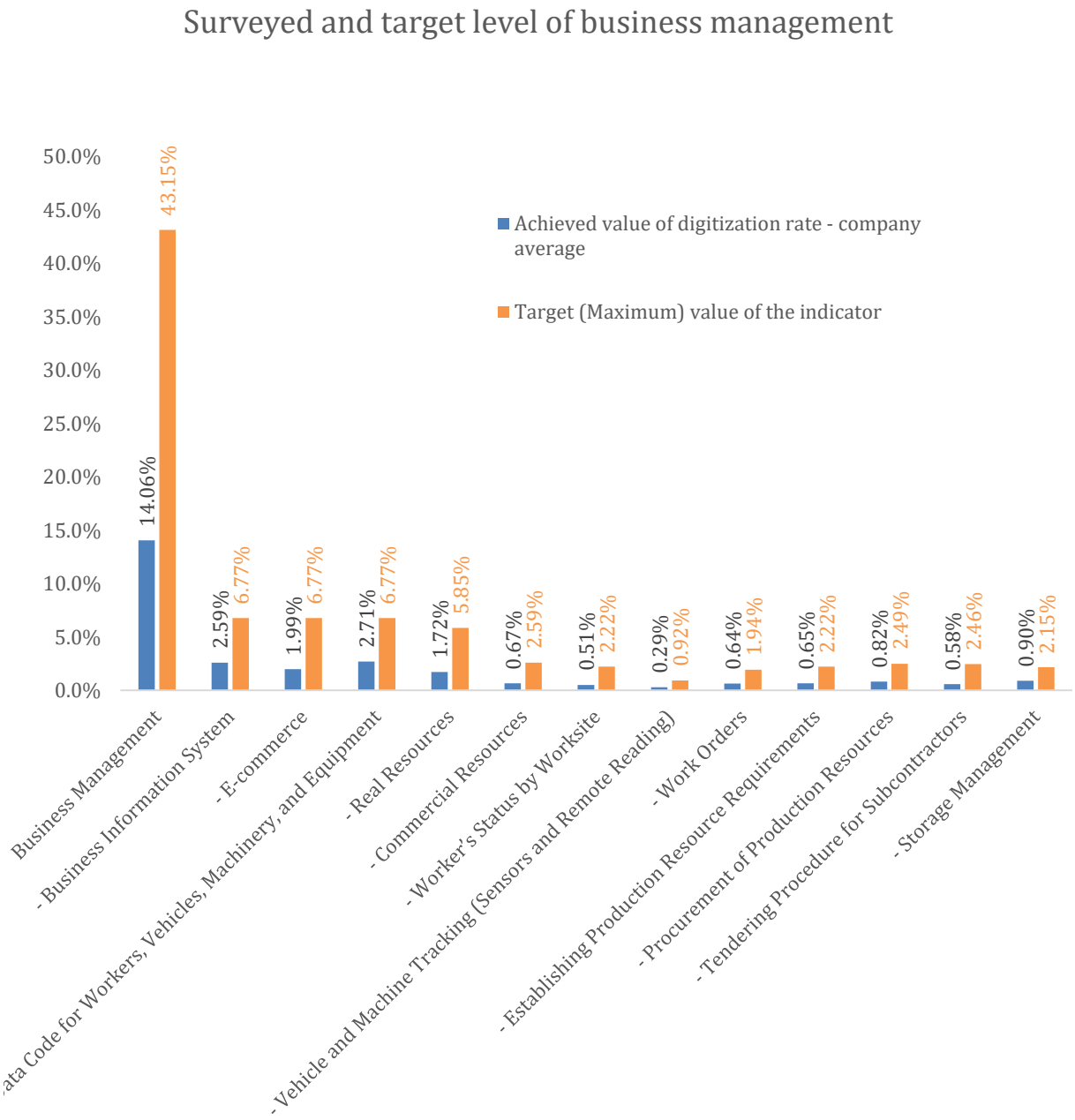
Financial and Time Monitoring of the Project

- **Average value:** 2.80%
- **Target:** 8.16%
- **Commentary:** The financial and time monitoring of the project has an average value of 2.80%, which is less than half of the target. Improvements in this area could help to improve transparency and project management. Enhanced digital tools for monitoring project progress and financial performance can lead to better decision-making and project outcomes.



Business Management

- **Average value:** 14.06%
- **Target:** 43.15%
- **Commentary:** The business part averages 14.06%, around a third of the target. Although higher than in other areas, it is still well below the target, indicating the need for a comprehensive digitisation of business processes. Streamlining business operations with integrated digital solutions can enhance overall efficiency and competitiveness.



FUTURE PLANS AND NEXT STEPS

We plan to conduct further evaluations at the end of the year and bi-annually thereafter to track progress and gather more data. These evaluations will be made publicly available to maintain transparency and encourage broader participation. Follow www.gzs.si/zgigm and www.fiec.eu for updates and additional information.

In our next steps, we aim to encourage more companies and educational institutions to use the DIG-IN-KPI AAT tool. We will continue to provide support and resources to help companies implement the recommended changes. Additionally, we will maintain regular communication with stakeholders to keep them informed of progress and new developments.

- Further evaluations: Conduct additional evaluations bi-annually to track progress and gather more data.
- Encourage usage: Promote the use of the DIG-IN-KPI AAT tool among more companies and educational institutions.
- Provide support: Continue offering resources to help companies implement recommended changes.
- Maintain communication: Keep stakeholders informed of progress and new developments.

NEXT STEPS

- Encourage more companies and educational institutions to use the DIG-IN-KPI AAT tool.
- Continue to provide support and resources to help companies implement the recommended changes.
- Maintain regular communication with stakeholders to keep them informed of progress and new developments.

IMPACT AND DATA UTILIZATION

The more organizations that complete the assessment, the more representative the data on digital maturity in the construction sector will be. Aggregated data will be analyzed within the FIEC Working Group Construction 4.0, and outcomes will be shared with relevant EC stakeholders. This data will be analyzed and presented in a report on the project's website. The report will showcase average digital maturity levels across different domains and indicators, categorized by country and company size. Additionally, it will provide insights into the most commonly used IT tools and allow companies to compare their current digital tools with those representing higher levels of digital maturity.

CONCLUSION

The DIG-IN-KPI AAT tool has proven to be a valuable resource for assessing digital maturity in the construction sector. While the current results are moderately insightful and representative, ongoing use of the tool will provide more robust data that will enable more precise recommendations and better support for companies and VET organisations on their digital transformation journey. By continuously analysing and reporting the results, we aim to foster a culture of digital innovation in the construction sector, which will ultimately lead to greater productivity, efficiency and competitiveness.

We are determined to use the insights gained from this tool to drive meaningful change in the construction sector. The future looks bright, and with continued effort and collaboration, we can achieve our goal of a digitally mature construction industry. The DIG-IN-KPI AAT tool has provided valuable insights into the digital maturity of construction companies in Slovenia, Croatia and North Macedonia. While the current sample size is relatively small, it is expected that continued use of the tool will generate more comprehensive data that will be analysed on a regular basis. The aggregated data will be presented in a report and shared within the FIEC Construction 4.0 Working Group and with relevant EU stakeholders to inform future digital transformation strategies.

The results of our DIG IN KPI project are in line with the Digital Economy and Society Index (DESI-Fact Pages | Shaping Europe's digital future (europa.eu)) reports for Croatia and Slovenia, which confirm the low level of digital transformation among SMEs. According to the DESI report, these countries face significant challenges in adopting digitalisation, especially in smaller companies. The findings and recommendations in this report are intended to guide companies and organisations on their digital transformation journey, leading to greater efficiency, competitiveness and sustainability in the construction sector. By relating the findings of this report to the Digital Economy and Society Index (DESI) reports for Slovenia and Croatia, we can better understand the broader digital landscape and identify areas for improvement. The DESI reports highlight similar challenges, such as the low level of digital transformation among SMEs, the lack of digital skills and the limited adoption of advanced digital technologies. These correlations underpin the validity of our findings and provide a broader context for our recommendations.

The findings and recommendations outlined in this report are intended to guide companies and organisations on their digital transformation journey and ultimately lead to greater efficiency, competitiveness and sustainability in the construction sector.

RECOMMENDATIONS

The analysis results show that construction companies in Slovenia, Croatia, and North Macedonia are still far from achieving their digitisation goals. The biggest gaps are in the areas of bills of quantities, financial evaluation, scheduling, and billing. Although some areas, such as the business side, have achieved slightly higher values, they are still well below the targets.

To improve the state of digitalisation in construction companies, it is necessary to:

1. **Developing and Implementing Digital Strategies**: Businesses need to develop comprehensive digital strategies that cover all key aspects of their business.
2. **Investing in Digital Technologies**: Investment in advanced digital technologies is needed to enable better project management, financial evaluation, and scheduling.
3. **Employee Education and Training**: Digitalisation requires skilled staff, so it is important that companies invest in the education and training of their employees.
4. **Cooperation with Technology Partners**: Cooperation with technology companies can help implement advanced solutions and accelerate the digitisation process.
5. **Measuring and Monitoring Progress: Regular measurement and monitoring of the progress** of digitisation is key to achieving the objectives set.

ANNEX

The questionnaire and the draft EN report extracted from DIG-IN-KPI-AAT tool

Digital transformation

Digitalisation strategy

- **Question:** [1/39] Digitalisation strategy [weight 4,74%]
- **Additional information (for the "info" button)**: A digitalisation strategy is a company's preparation for digitalisation. It is about examining the company's work processes and selecting the appropriate ICT equipment. It mainly concerns the work and responsibilities of the management structures in the company.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No documents	Digitalisation level 0 [0%] The company does not reach the 20% level of digitalisation of enterprises according to these indicators and has no documents in place for investment in digitalisation.
1 Measures analysis	Digitalisation level 1 [30%] The company has analysed its business and project processes and identified all available options for digitalisation in the company.
2 Selection of equipment	Digitalisation level 2 [50%] The company analysed the digitalisation measures from a cost perspective and selected specific equipment to increase digitalisation.
3 Findings of accompanying measures	Digitalisation level 3 [70%] After selecting the digitalisation equipment, the company also identified other accompanying measures (standardised databases, staff training, new recruitments, surplus staff,...).
4 Provision of accompanying measures	Digitalisation level 4 [100%] The company has also ensured that all other accompanying measures (standardised databases, staff training, new recruitments, staff surplus, etc.) are in place.

Additional question:

Which department is responsible for implementing the content of the indicator?

REPORT

- **Additional information text**: The Digitalisation strategy depends on the company's management structures. Awareness of the importance of digitising project and business processes is essential for quality and efficient business management. A digitalisation strategy includes both modern ICT tools and the databases used by the ICT tools.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you analyse your company's business and project processes.
1		After analysing your company's processes, we recommend selecting the right ICT equipment.
2		After purchasing ICT equipment, we advise you to analyse whether you will provide the appropriate databases to work with ICT tools by purchasing from vendors or developing them in-house.
3		After analysing which databases are suitable, we advise you to buy the databases or get the right experts to build them for you.
4		You are reaching the highest level of your digitalisation strategy.

Introducing a digital culture in your company

- **Question:** [2/39] Implementing a digital culture in the company [weight 5,42%]
- **Additional information (for the "info" button)**: introducing a digital culture in the company means preparing employees to embrace digitalisation and to familiarise and learn the new way of working that digitalisation requires.

- **Answers with a short and a long version.**

Short answer	**Long answer**
0 No documents	Digitalisation level 0 [0%] The company does not reach the 20% level of digitalisation of enterprises according to these indicators and has no documents in place for investment in digitalisation.
1 Equipment purchase	Digitalisation level 1 [30%] The company has purchased ICT equipment and identified what actions are needed in the area of employee training to introduce or increase digitalisation.
2 Education	Digitalisation level 2 [50%] The company has organised training for all employees who have undergone changes to their work due to the introduction of digitalisation.
3 More than half have problems	Digitalisation level 3 [70%] More than half of employees (satisfaction surveys, frequency of help-seeking, lower than expected workload) have difficulties with the digital transition.
4 Less than a quarter have problems	Digitalisation level 4 [100%] Less than a quarter of employees (satisfaction surveys, frequency of help-seeking, lower than expected workload) have problems with the digital transition.

Additional question:

Which department is responsible for implementing the content of the indicator?

REPORT

- **Additional information text**: Implementing a digital culture in a company starts with identifying the actual and necessary knowledge to work effectively with new ICT tools. It continues with training. Employee acceptance of digitalisation is then measured by identifying job satisfaction and performance, and is promoted through additional training.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you analyse your company's business and project processes.
1		After purchasing ICT equipment in your company, we recommend you choose the appropriate training.
2		After the training, we advise you to carry out surveys to measure your satisfaction and effectiveness with the new ICT tools.
3		We recommend that you analyse why the acceptance of digitalisation is so low and accept the conditions to make digitalisation more acceptable.
4		You are achieving the highest level of digital culture.

Project management

Project Information System

- **Question:** [3/39] Project Information System - CERP [weight 2,95%]
- **Additional information (for the "info" button)**: An application that processes data from the perspective of execution works and project production resources and is designed for cost and schedule management of construction projects. With an analytical and systematic approach, it enables the identification of financial and schedule anomalies in a project and allows early action. The application enables the creation of Bill of Quantities (BoQ), construction cost estimation, scheduling, monthly project accounting and project performance analytics.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No application	Digitalisation level 0 [0%] No dedicated application is used for monitoring project processes
1 Local application	Digitalisation level 1 [30%] A dedicated BoQ and project accounting application is used, which is installed on a local computer. Data is exchanged by sending files between computers.
3 Network application	Digitalisation level 3 [80%] One dedicated project application is used, on which several users can work at the same time. The application stores data in the cloud (terminal access with data on the server) and has an administrator who manages user access to application modules with different levels of data access (cost estimators, technologists, commercialists, site managers, project managers, directors, etc.). The application does not allow project information to be analysed at the level of the sum of all projects (project portfolio).
4 Online project portfolio application	Digitalisation level 4 [100%] One dedicated project application is used, on which several users can work at the same time. The application stores data in the cloud (terminal access with data on the server) and has an administrator who manages user access to application modules with different levels of data access (estimators, technologists, commercialists, site managers, project managers, directors, etc.). The same application also allows time-dependent analysis of project resources (materials, labour, machinery, vehicles, money) - strategic planning at the level of the company as a project of projects.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

- **Additional information text**: The application is essential for managing the data that enables effective project management. The application allows for the creation of Bills of Quantities, cost estimation of BoQ items, monthly project billing, scheduling and project performance analytics. The better applications enable team working, multiple users on a common database and data stored in the cloud rather than on local computers. Better applications also have the ability to manage production resources on an enterprise-wide level, as a project portfolio of individual projects.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you choose an ICT tool for construction project management Digitalisation level 1: Blist, Best Digitalisation level 1: GALA, Gala Software Digitalisation level 3: Xpert, Axis
1		We recommend you choose a networked ICT application for construction project management. Digitalisation level 3: Xpert, Axis
2		
3		We recommend you choose the CERP Construction Information System, which also enables strategic planning of production resources for the whole company.
4		You achieve the highest level of Digitalisation for a project information system.

Web portal and common data environment

- **Question:** [4/39] Web-based project portal and CDE (Common Data Environment) [weight 1, 72%]
- **Additional information (for the "info" button)**: The online project portal allows the publication and storage of shared project documents used by multiple users with hierarchical access for the same project in one place:
  - tender and contract documents
  - building permit documentation
  - project documentation for architecture, structures, installations,...
  - timetables,
  - monthly reports,
  - billing situations,
  - changes to the project,
  - materials and equipment
  - minutes of meetings,
  - construction photos,
  - ...

- **Answers with a short and a long version.**

Short answer	Long answer
0 Local disks	Digitalisation level 0 [0%] Documents are exchanged between participants via e-mail. Documents are stored on users' local drives.
1 Server without user rights	Digitalisation level 1 [20%] Space is available on the server where the common documentation for the project is collected, but access is not restricted by rights. Everyone can see and modify everything.
4 Web portal with user rights	Digitalisation level 4 [100%] The online project portal keeps the common documents for a project in one place. Documents can be viewed or corrected in one place. Access to documents and folders on the server is selective according to user rights.

Co-funded by the European Union
DIG-IN-KPI

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

- **Additional information text**: A web portal that allows project documents to be stored in one place improves the quality of data, as key information is collected and accessed in one place only. This avoids incorrect and outdated versions of project documentation, while providing users with the fastest possible access to documents as soon as they are published by the producer. Better applications have hierarchical access to data according to the roles of users on the project.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you choose an ICT tool for a common data environment. Digitalisation level 4: Sharepoint, Microsoft Digitalisation level 4: DMS Next, EBA Digitalisation level 4: Dalux Box Pro
1		We recommend choosing a more advanced ICT tool for a shared data environment, with hierarchical access to documents, according to user rights. Digitalisation level 4: Sharepoint, Microsoft Digitalisation level 4: DMS Next, EBA Digitalisation level 4: Dalux Box Pro
2		
3		
4		You achieve the highest level of Digitalisation for the online project portal and the common data environment.

Construction diary

- **Question:** [5/39] Construction diary [weight 1,85%]
- **Additional information (for the "info" button)**: A construction diary is a document that records the status and events related to the execution of works on a construction site:
  - implementation of the works,
  - the state of the workforce; and
  - weather data.
- **Answers with a short and a long version.**

Short answer	Long answer
0 Manual entry on paper forms	Digitalisation level 0 [0%] The construction log data is entered manually by pen in forms in a book located on the construction site.
2 Network drive uncontrolled acces	Digitalisation level 2 [40%] The construction log data shall be filled in in document on a network drive. Anyone with access to the network drive can enter, no time is recorded, no digital signature is enabled. At the end of the day, a physical printout of the log sheet for that day is taken. The physical printout of the logbook sheets is the relevant document and must be physically signed. However, it shall be possible to view the scanned entries in the construction diary on a network drive.
3 Network application with controlled access	Digitalisation level 3 [80%] The construction diary is filled in daily in a cloud-based system with a personal password. Each entry shall record the identity of the entrant and the time of entry. Only the current day may be entered. Retrospective corrections are not possible. By checking and digitally signing, the persons responsible shall confirm that they are aware of the information in the construction logbook.
4 Automatic data entry	Digitalisation level 4 [100%] The construction diary is automatically populated into the cloud-based system for certain data. Any additional entry of authorised participants in the construction is still possible. The description of the works carried out (work orders or sensory data capture for the BIM model), the weather situation and the status of the workforce (types and number of workers) are automatically entered.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

- **Additional information text**: A construction diary is a document that describes the progress of construction and is used by the various participants in the construction process to inform each other of important findings by making entries. More advanced construction diary tools allow the automatic identity of the entrant and the entry for the current day only. The most advanced tools allow automatic suggestions for the entry of work progress and site status.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend choosing an ICT tool for the construction diary. Digitalisation level 2: Dalux Field Digitalisation level 3: DMS Next, EBA
1		
2		We recommend choosing an ICT tool for the construction logbook that has entry control. Digitalisation level 3: DMS Next, EBA
3		We recommend choosing an ICT tool for the construction logbook that automatically enters data on site work and weather based on data already entered in work orders and weather sensors.
4		You achieve the highest level of Digitalisation for a construction diary.

Weather data recording

- **Question:** [6/39] Weather data recording [weight 0,60%]
- **Additional information (for the "info" button)**: The weather is monitored on the construction site by whether equipment and records information on temperature, humidity, wind strength and direction, and the amount and shape of precipitation.
- **Answers with a short and a long version.**

Short answer	Long answer
0 Manual reading	Digitalisation level 0 [0%] Weather devices need to be manually read and the status manually recorded.
4 Automatic reading	Digitalisation level 4 [100%] Weather sensors devices automatically record weather data for temperature, humidity, wind and precipitation for each hour in a file.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

- **Additional information text**: Capturing weather data is useful for demonstrating construction constraints due to rain, snow, cold, heat and for demonstrating conditions that may affect the quality of construction, such as concrete care. With automatic logging, data can be read at shorter time intervals, giving more accurate and reliable data.

	Short answer from the questionnaire (used in the MADM model)	Recommendations for the user in the report based on the selected answer
0		We recommend choosing an ICT device to record weather data.
1		
2		
3		
4		You achieve the highest level of Digitalisation for capturing weather data.

Bill of Quantities

Format of the priced Bill of Quantities

- **Question:** [7/39] Format of the priced Bill of Quantities [weight 1.23%]
- **Additional information (for the "info" button)**: The BoQ format refers to the data structure for the BoQ. If the data structure is unified - standardised - then exporting and importing data into different programs is easy. Otherwise set rules needs to be applied on how and where to read the relevant data.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No rules	Digitalisation level 0 [0%] There are no rules on the format of BoQ. The data for an BoQ item is not in one line. The BoQ is prepared in multiple tabs in Excel files. Hence the data must be further processed (define WBS, merge rows, problem of multiple units of measurement and quantities within one item) if the data are to be imported into the BoQ application. The summation of areas and recapitulation is done manually using the cell summation formula.
1 Item in its own row	Digitalisation level 4 [100%] The format of the BoQ is standardised so that it can be easily imported into the application without any further data processing. This means that each row is its own item and that each item has its own columns in the table: - WBS, - Code, - Description, - Unit of measurement, - Quantity, - Unit price, - Cost amount (quantity * Unit price)

Additional question:

Which IT tool do you use to implement the content of the indicator??

REPORT

- **Additional information text**: The format of Priced BoQ and Unpriced BoQ is very important for data exchange. How the data is organised is important when importing and exporting data. If it is not known which data is important and where can be read, it is necessary to manually correct the data for importing. It is therefore necessary that the data exchange file for the inventory has a standardised format.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you choose any ICT application for editing BoQ. Any IT inventory management application can only work if it has standardised data. BoQ data format will automatically be standardized when exporting BoQ from ICT application for editing BoQ.
1		
2		
3		
4		You achieve an appropriate level of Digitalisation for the BoQ data format. Digitalisation level 4: Xpert system, Axis

Text description of works in BoQ item

- **Question:** [8/39] Text description of works in BoQ item [weight 3,08%]
- **Additional information (for the "info" button)**: Text description of works in the BoQ item refers to the description of the service or/and product, correctly defined in its content. The description must contain the information necessary to sufficiently and unambiguously define the object of the work to determine the unit price of the BoQ item. Standardisation of the text description information greatly facilitates the correctness of the description of the work in the item. Choose the type of database of the works descriptions you use most.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No standardization	Digitalisation level 0 [0%] There is no standardised data prepared in advance to form the BoQ item text.
1 List of items	Digitalisation level 1 [30%] There is a list of standardised BoQ items. The list of items has up to 50 different items for 1 technological process (e.g. concreting a slab). The user selects the items for his project from the list.
4 Data parameterization	Digitalisation level 4 [100%] There is a database of standardised data that can be used to create standardised BoQ item text for a project. With such a database, theoretically millions of different items can be created for one technological process (e.g. concrete slab).

Additional question:

Which database do you use to implement the content of the indicator?

REPORT

- **Additional information text**: The quality of the text description of works in an item has a significant impact on the price of the item and consequently on the contract value. The quality of the item text description is greatly increased if a standardised database for item text descriptions is used. The accuracy of the item text description is increased if the number of data is sufficiently large to take into account all significant price influences.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you choose a standardised database. Digitalisation level 1: List of items for construction work LB HB, Austria Digitalisation level 4: Standardised database for construction BoQ Xbase, Axis
1		We recommend a database to help you describe the works in the BoQ in more detail. Digitalisation level 4: Standardised database for construction BoQ Xbase, Axis
2		
3		
4		You achieve the highest level of Digitalisation for the quality of the description of the works in the item.

Quantity for BoQ item

- **Question:** [9/39] Quantity for BoQ item [weight 3,08%]
- **Additional information (for the "info" button)**: The quantity for BoQ item has a strong influence on the price of the item. The focus of the functionality is on accuracy, transparency and traceability of the quantity calculation. The quantity can be calculated manually or automatically from the 2D drawings or 3D model. For the estimation, please select the method of quantity calculation you use the most.
- **Answers with a short and a long version.**

Short answer	Long answer
0 Manual calculation is not documented	Digitalisation level 0 [0%] Quantities for BoQ items are calculated manually in Excel.
1 Calculation documented in the application	Digitalisation level 1 [30%] The quantities for the BoQ items are calculated manually, but in the BoQ application, so that there are pre-estimates. There is a clear traceability in the application of how the calculation of quantities has been made, so that the location on the object for each measurement in the calculation can be seen. The quantity can be sufuciently explained with indication of the location with a description of e.g. floor, axis, etc. and the arithmetic calculation.
2 Calculation in the application for 2D plans	Digitalisation level 2 [50%] Quantities are calculated using an application that can import 2D plans. The application can be used to manually edit (summarize) areas [m2], lengths [m] or pieces. More advanced applications can identify room and wall areas to the user in advance.
3 Manual calculation with link to 3D model	Digitalisation level 3 [60%] The quantities for the BoQ items are produced manually, but in the BoQ application, so that there are pre-estimates. There is a clear traceability in the application of how the calculation of quantities has been made, so that the location on the object for each measurement in the calculation can be seen. The location reference is described by linking the BoQ item to the elements in the BIM model from which the formula quantities are calculated.
4 Automatic calculation from BIM	Digitalisation level 4 [100%] Quantities for BoQ items are automatically calculated from attributes in the BIM model.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

- **Additional information text**: The calculation of quantities for BoQ items has a significant impact on the price of the item and consequently on the contract value.

Transparency and clarity are important when calculating quantities so that the calculation can be verified. This means that the location of the elements and the dimensions from which they are calculated are clearly visible.

A less advanced way is to use special QTO (quantity take off) applications to calculate areas, lengths and count pieces based on 2D plans.

However, the concept of linking elements in the 3D model and items of the BoQ is considered to be more advanced. The location can be described in words or with BIM elements. The highest level of Digitalisation is the automatic calculation of quantities directly for each BoQ item from the BIM model.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you choose an ICT tool to calculate your quantities. Digitalisation level 2: On-Screen TakeOff, On centre software Digitalisation level 2: Togal.AI Digitalisation level 3: Xpert, Axis
1		We recommend you choose an ICT tool that will help you calculate quantities faster. Digitalisation level 2: On-Screen TakeOff, On centre software Digitalisation level 2: Togal.AI Digitalisation level 3: Xpert, Axis
2		We recommend choosing an ICT tool with which you have 3D model and items linked. Digitalisation level 3: Xpert, Axis
3		We recommend that you choose an ICT application that allows you to calculate quantities for BoQ items from automatic measurements in the BIM model.
4		You achieve the highest level of digitalisation for calculating quantities in an item.

Making of BoQ

- **Question:** [10/39] Making of BoQ [weight 1,66%]
- **Additional information (for the "info" button)**:

The making of an BoQ refers to whether the BoQ is created manually or automatically, and whether the descriptions are created freely or on the basis of standard data. There is also a difference in whether a single user can work on the BoQ or whether several users can work on it at the same time.

- **Answers with a short and a long version.**

Short answer	**Long answer**
0 No application	Digitalisation level 0 [0%] No specific app is used. The BoQ is made in Excel. Quantities are calculated manually.
1 Local application	Digitalisation level 1 [20%] A dedicated application installed on a local disk is used, without the possibility of using standard databases to create BoQ. Only one person can work on an BoQ at a time.
2 Network application with standard BoQ	Digitalisation level 2 [50%] A dedicated network application is used to produce standardised BoQ. BoQ Items can be edited in the application. Several people can work on the same BoQ at the same time. The description, quantity, price, tree structure of the BoQ can be changed. The tree structure of the chapters in the BoQ is created. BoQ Items can be moved around the chapters in the BoQ.
4 Standard BoQ based on the BIM model	Digitalisation level 4 [100%] A dedicated network application is used to produce standardised BoQ based on a standard BoQ database and a 3D BIM model. For most BoQ items, a description of the works and a calculation of quantities are automatically produced based on the standard database and the 3D BIM model.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: In less sophisticated applications, only one cost engineer can work on a BoQ and the BoQ is produced sequentially by type of works. Or many cost engineer are working on many parts of BoQ on separate files and all the files that comprise BoQ are after completion merged together. In more advanced applications, however, several BoQ makers may be working on the same BoQ at the same time so that there is less risk of duplication of items. In this case, everyone concerned has a real-time view of the creation of the whole BoQ which is being created. The highest level of Digitalisation is represented by the automatic production of a standardised bill of quantities based on a standardised database and a 3D BIM model.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you choose an ICT tool to create your BoQ. Digitalisation level 2: Xpert, Axis
1		We recommend you choose an ICT tool to create a standardised BoQ of works on which several BoQ-makers can work at the same time. Digitalisation level 2: Xpert, Axis
2		We recommend choosing an ICT tool that allows you to automatically create a bill of quantities based on a standardised database and a 3D BIM model.
3		
4		You achieve the highest level of Digitalisation to create an BoQ of works.

Contractor's lots

- **Question:** [11/39] Contractor's lot [weight 2,46%]

Additional information (for the "info" button): The form of the contract with co-contractors or sub-contractors gives rise to different relationships regarding the call for tenders and the invoicing of the works to the contracting authority. It is therefore first necessary to divide the project BoQ into co-contractor and sub-contractor parts. The subcontracting lots are then put out to tender by main contractor and tenders are obtained and compared with each other. A subcontract billing lot is also created, where the contractor assumes the role of client and the subcontractor assumes the role of contractor.

- **Answers with a short and a long version.**

Short answer	Long answer
0 Lots in Excel	Digitalisation level 0 [0%] The breakdown of the BoQ of works into the different subcontractors shall be made in excel and sent by e-mail to the subcontractors.
2 Separate subcontractor lot files from the application	Digitalisation level 2 [30%] Use a programme where the files are separate: - Exporting tender file for subcontractors. - Importing tender files from subcontractors. - Importing the invoice file for subcontractor. The software allows to upload the tender files of subcontractors where tenders can be compared.
3 Subcontracted network application with exports and imports	Digitalisation level 3 [60%] A system network application shall be used, containing all the data for the call for tenders and the tenders received, as well as the invoicing to the subcontractors. The application divides the BoQ into subcontracting lots. The request is forwarded to the subcontractors who submit their bids. The bids are compared within the application. The selected subcontractor shall be invoiced for the work by means of monthly invoices. Data is exchanged in a standardised file format by email.
4 Network application lots without imports and exports	Digitalisation level 4 [100%] A system network application shall be used, containing all the data for the call for tenders and the tenders received, as well as the invoicing to the subcontractors. The application divides the BoQ into subcontracting lots. The request is forwarded to the subcontractors who submit their bids. The bids are compared within the application. The selected subcontractor shall be invoiced for the work by means of monthly invoices. All work is done in the app, so subcontractors also get rights to use the app.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text:

The lowest level of Digitalisation is where separate files are for subcontractor inquiry, quotation and invoicing, which need to be processed separately in a local programme. A higher level of Digitalisation means using a network application into which files also need to be imported and exported, which are sent by email, but the data is then stored and accessed centrally in one place. The highest form of Digitalisation is the use of a network application on which all users work, each with their own level of hierarchical access rights and data is stored in central place.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend choosing an ICT tool that allows you to split the project into contractor and subcontractor parts. Digitalisation level 2: DMS Next-EBA, Digitalisation level 2: Dalux Tender Digitalisation level 4: Xpert, Axis
1		
2		We recommend you choose a more advanced networked ICT tool that allows you to access all subcontracting data in one place. Digitalisation level 4: Xpert, Axis
3		We recommend you choose a more advanced networked ICT tool that allows you to access all subcontractor data in one place, with the possibility of direct access in the application for subcontractors too, without exporting and importing and sending files by email. Digitalisation level 4: Xpert, Axis
4		You achieve the highest level of Digitalisation.to create an BoQ of works

Financial evaluation

Calculative resources

- **Question:** [12/39] Calculative resources [weight 2,46%]
- **Additional information (for the "info" button)**: The Calculative resource Database is intended for cost estimating - the calculation of unit prices for BoQ items with calculative resources as cost drivers. Calculative resources are used to make resource plans (material, labour, machinery, vehicles, etc.) and financial plans. One calculative resource can represent one or more of the real resources.
- **Answers with a short and a long version.**

Short answer	Long answer
0 No calc resources	Digitalisation level 0 [0%] There is no resource base for making calculations.
1 Calc resource data base without update	Digitalisation level 1 [20%] There is a stand-alone database for the calculative resources, but it is not maintained by an administrator or regularly updated with descriptions and prices.
2 Calc resource data base with update	Digitalisation level 2 [60%] There is a common unified database of calculative resources. The database covers the field of construction works and has an administrator in charge of updating the descriptions and prices of costing resources.
3 Calc resources linked to the real resource for construction work	Digitalisation level 3 [80%] There is a common unified database of calculative resources. The database defines the link between calculative and real resources. The database contains all construction works and has an administrator in charge of updating the descriptions and prices of costing resources.
4 Calc resources linked to real resources for construction and craft works	Digitalisation level 4 [100%] There is a common, unified database of calculative resources. The database defines the link between calculative and real resources. The database contains all construction and craft works and has an administrator in charge of updating the descriptions and prices of costing resources.

Additional question:

Which database do you use to implement the content of the indicator?

REPORT

- **Additional information text**: The calculative resource database is a database used to estimate the price of works and to plan the consumption of production resources and costs at the level of project processes. One calculative resource can represent one or more of the real resources.
A prerequisite for a quality database is the assignment of a database administrator to keep the resource descriptions and prices up to date. Better Digitalisation means resource coverage for as large a range of works as possible within the company. A higher level of digitalisation means linking project and business codebooks or linking calculative and real resources.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you set up a database of calculative resources.
1		We recommend that you appoint an administrator for the Calculative Resource Database.
2		We recommend that you establish a link between calculative and real resources to monitor the planned and actual use of production resources.
3		We recommend that you extend your database of costing resources to all the areas covered by your company.
4		You achieve the highest level of digitalisation for calculative resources.

Construction calculation and database for resource consumption rates

- **Question:** [13/39] Construction calculation and database for resource consumption rates [weight 2,46%]
- **Additional information (for the "info" button)**: Construction calculation is the process of setting the price of a BoQ item and determining the type and quantity of calculative resources needed to carry out the work described in BoQ item. Calculation is produced by means of resource consumption rates for technological processes, which contain the calculative resources as cost bearers.
- **Answers with a short and a long version.**

Short answer	Long answer
0 Prices without calculation	Digitalisation level 0 [0%] Prices in the BoQ are determined by the entry of a number only, without the use of resource rates and resources.
2 List of resource rates	Digitalisation level 2 [50%] The price of an BoQ item is determined manually by selecting the resource and calculative resources from the list of process resource consumption rates and the list of calculative resources.
3 Parameterized resource rates	Digitalisation level 3 [80%] The calculation uses a database of parameterised process consumption rates, where the resource consumption can be fine-tuned by changing the parameters.
4 Automatic price calculation from resource rates	Digitalisation level 4 [100%] The price of the item is determined automatically using process consumption rates and calculative resources. There is a link between the process's consumption rates and the BoQ item description.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: Construction calculation means assigning resources to BoQ items. A prerequisite for the rapid calculation is the existence of a database of process's consumption rates. Low level digitalisation means a list of process's consumption rates where the parameters are described in the process's consumption rates description. A higher level of digitalisation is represented by a database of parameterised process's consumption rates where parameters can be adjusted. The highest level of digitalisation is the automatic selection of resource rates and resources according to the BoQ item description.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you use the construction calculation and process's consumption rates database to estimate the value of the works. Digitalisation level 3: Xpert, Axis
1		
2		We recommend that you use the parameterised process's consumption rates database to estimate the values of the items more accurately. Digitalisation level 3: Xpert, Axis
3		We recommend using a system that allows automated calculation based on the item description.
4		You achieve the highest level of digitalisation for construction costing.

Database of past project BoQ items

- **Question:** [14/39] Database of past project BoQ items [weight 1,69%]
- **Additional information (for the "info" button)**: A database of past project BoQ items with unit prices is useful additional information when pricing a BoQ item if there is no database of resources and process consumption rates or no time to carry out a construction calculation. However, it is important to bear in mind that these are similar prices for similar items and not precisely calculated prices for specific items.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 No database	Digitalisation level 0 [0%] There is no BoQ item's database with prices of past projects.
2 Database search with filters	Digitalisation level 2 [50%] There is a database of BoQ items from past projects. The user can manually search for similar items by part or whole of the item description, unit of measurement with the aim of extracting BoQ items with prices and dates for past projects.
3 Database search with artificial intelligence	Digitalisation level 4 [100%] Using artificial intelligence technology, the software can estimate the prices in the new bid and their likelihood of accuracy, based on standardised items and big data of items with prices from past projects.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The database of past projects is a useful functionality of an ICT application if it can be used to query prices. A lower level of Digitalisation is achieved by manual queries of the database using filters. A higher level is achieved by automated suggestions of similar items and automatic consideration of prices which consider contemporary market situation.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you create a database of cost estimates for past projects to estimate the value of the works. Digitalisation level 2: Xpert, Axis
1		
2		You can achieve a higher level of digitalisation by integrating AI that will select the best approximations to your BoQ items from a database of past projects.
3		
4		You achieve the highest level of Digitalisation for your database of past projects.

Time scheduling

Time schedule

- **Question:** [15/39] Time schedule [weight 2.46%]
- **Additional information (for the "info" button)**: The time schedule, in the form of a gantt chart or linear schedule, defines the work activities, their duration and their interrelationships.
If it is created with an application that supports the network planning technique, the critical path can also be calculated.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 No links between activities	Digitalisation level 0 [0%] Creating a time schedule that does not allow for interdependence and connection of activities and does not allow for an automatic search for the critical path.
2 Links between activities	Digitalisation level 2 [50%] Creating a time schedule in a dedicated application that allows activities to be linked.
4 Critical path	Digitalisation level 4 [100%] Creation of a time schedule in a dedicated application in the form of a gantt chart (e.g. MS Project) or a linear time schedule (e.g. Tilos). The application allows the definition of activities and the determination of the duration of activities and the interconnections between activities using a network planning technique that allows the critical path to be found.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: Time schedule is the document that defines the activities of the project. Activities should be selected on a location basis so that planned and actual progress can be compared. The ICT application used to produce the time schedule must be able to identify the interdependencies between activities and to define the critical path of activities. A time schedule is also essential for the systematic and integrated production resource plan and a financial plan.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using one of the ICT applications to create your time schedules. Digitalisation level 4: MS Project, Microsoft Digitalisation level 4: Tilos
1		
2		We recommend using an ICT application to produce critical path time schedules. Digitalisation level 4: MS Project, Microsoft Digitalisation level 4: Tilos
3		
4		You are achieving the highest level of Digitalisation for the Time schedule.

Linking BoQ items and activities in the Time schedule

- **Question:** [16/39] Linking BoQ items and activities in the Time schedule [weight 2.46%]
- **Additional information (for the "info" button)**: by linking items (prices) and activities (time), a financial plan can be created which can be automatically updated by rescheduling activities.
If the items are supported by a construction calculation (resources) and linked to activities, resource plans (material, labour, machinery, vehicles) can be created and automatically updated by reallocating activities.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 no links	Digitalisation level 0 [0%] Items and activities cannot be linked. Therefore, resource and financial plans cannot simply be updated after a change in technology or a change in the duration of an activity, hence the financial and resource plan has to be made from scratch.
2 Links for prices	Digitalisation level 2 [50%] An activity in the time schedule can be linked to an item in the BoQ in such a way that one item can be linked to one or more activities, or one activity can be linked to one or more items. In this case, the items have only prices and only a financial plan can be made.
4 Links for resources and prices	Digitalisation level 4 [100%] An activity in the schedule can be linked to an item in the BoQ in such a way that one item can be linked to one or more activities or one activity can be linked to one or more items. In this case, the items have not only prices but also calculative resources, hence a resource plan (materials, labour, machinery, vehicles) can be made in addition to the financial plan.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The linking of the BoQ items and activities in the time schedule is essential for the systematic preparation of the resource and financial plan. For the financial plan, only the pricing of the items is necessary. For the resource plan, a construction calculation with resources is necessary. The linking of BoQ items and activities allows for immediate changes to the resource and financial plans if the duration of the activities in the time schedule changes.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application that allows you to link the BoQ items to the activities in the time schedule. Digitalisation level 4: Xpert, Axis
1		
2		We recommend using an ICT application that allows you to link the BoQ items and the activities in the time schedule, both for prices and resources. Digitalisation level 4: Xpert, Axis
3		
4		You achieve the highest level of digitalisation to link the time schedule and the estimate.

Linking elements from the BIM model and activities from the time schedule

- **Question:** [17/39] Linking elements from the BIM model and activities from the time schedule [weight 1,54%]
- **Additional information (for the "info" button)**: The linking of BIM model elements and activities from the time schedule is direct in the BIM modeller and indirect in the non-BIM application, where there are 2 links: 1. BIM elements – BoQ items and 2. BoQ items – time schedule activities. The purpose of the link between the BIM model and time schedule activities is to show the sequence of the construction or to produce a 3D animation of the construction. This is intended mainly for commercial display to the public and the client, less for professional engineering benefits.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 no links	Digitalisation level 0 [0%] The elements of the BIM model and the activities in the schedule are not linked.
0 links exist	Digitalisation level 4 [100%] The BIM model elements and the activities in the schedule are linked directly or indirectly by linking the BIM elements to the items and the items to the activities in the schedule.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: Direct linking of BIM elements and activities in the time schedule is used in the BIM application. The practical application is a visual representation of the construction sequence. With this link, financial plans can be produced in BIM applications if the values of the elements are specified, or resource plans if resources are linked to the elements. However, practice shows that financial and resource plans with BIM applications are of poorer quality because they do not have well-developed construction calculation functionalities, nor do they have the necessary databases for resources.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		If you do not need 3D animation of the construction, then there is no need to link the BIM model and the schedule.
1		
2		
3		
4		You achieve the highest level of digitalisation to link the BIM model and the schedule.

Billing

Calculation of monthly situations (billing quantities)

- **Question:** [18/39] Calculation of monthly situations (billing quantities) [weight 1.85%]
- **Additional information (for the "info" button)**: Monthly construction situations are a monthly accounting of the work performed. They are made based on priced BoQ by taking into account the cumulative quantities on the accounting day for the BoQ items of work performed.
- **Answers with a short and a long version.**

Short answer	Long answer
0 situations in xls	Digitalisation level 0 [0%] Monthly situations are made in an xls file. There is a different file for each month.
1 local application with file export	Digitalisation level 1 [20%] Monthly situations are calculated in a dedicated application, but a new file must be created for each month. Each file relates to one month only.
2 network application with one quantity	Digitalisation level 2 [40%] Monthly situations are made in a dedicated network application that stores data for all monthly situations. It is only possible to enter one number for quantities, without knowing whether it is for executed quantity (contractor) or for approved quantity (supervisor) or for invoiced quantities regarding contract specifications. The quantities for the items are calculated manually and entered into the application manually.
4 network application with multiple quantities	Digitalisation level 4 [100%] Monthly situations are produced in a dedicated network application that stores data for all monthly situations. It is possible to enter several quantities for each BoQ item: executed quantity (contractor) and approved quantity (supervisor) and invoiced quantity regarding contract specifications. The quantities for the items are calculated manually and entered into the application manually.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The monthly situations billing is one of the most important tasks on the project. Therefore, the data must be clear and transparent. The advantage is if it is produced in a networked application that can be accessed by everyone concerned of billing. It should also be clear where the contractor and the supervisor stand on the quantities carried out and how much is approved according to the form of the contract.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application for monthly billing of the works carried out. Digitalisation level 4: Xpert, Axis
1		We recommend using a networked ICT application with multi-user capability for monthly billing. Digitalisation level 4: Xpert, Axis
2		We recommend using a network application where you can enter actual quantities produced, approved quantities and invoiced quantities. Digitalisation level 4: Xpert, Axis
3		
4		You achieve the highest level of digitalisation for the billing of works carried out.

Accounting for co-contractors and sub-contractors

- **Question:** [19/39] Accounting for co-contractors and sub-contractors [weight 1,66%]
- **Additional information (for the "info" button)**: In the case of a joint venture of multi-contractor invoice, it is an invoice to the investor, with each of the co-contractors completing its own scope of works.

Subcontractor accounting is the accounting of subcontractors to the main contractor.

The accounting is based on the priced BoQ and the quantities executed on the cut-off date.

- **Answers with a short and a long version.**

Short answer	Long answer
0 situacije v xls	Digitalisation level 0 [0%] Monthly situations are made in an xls file. There is a different file for each month.
1 lokalna aplikacija z izvozom datoteke	Digitalisation level 1 [20%] Monthly situations are calculated in a dedicated application, but a file must be uploaded each time. Each file relates to one month only.
2 mrežna aplikacija z eno količino	Digitalisation level 2 [40%] Monthly situations are produced in a dedicated network application that stores data for all monthly situations. The system only allows the tracking of one quantity number, and it is not clear whether the number relates to actual quantities performed, approved quantities or invoiced quantities by month for each subcontractor on the project. The BoQ item's prices and accounting terms in the same project may be different depending on the relations of the subcontractor-contractor and contractor-investor, so the situations must be treated separately on the line Subcontractor --> Main Contractor and Main Contractor --> Investor.
3 mrežna aplikacija z več količinami	Digitalisation level 4 [100%] Monthly situations are produced in a dedicated network application that stores data for all monthly situations. The system allows for separate monitoring of the quantities for each BoQ item: actual quantities performed, the approved quantities and the invoiced quantities by month for each contractor and subcontractor on the project. The BoQ item's prices and accounting terms in the same project may be different depending on the relations of the subcontractor-contractor and contractor-investor, so the situations must be treated separately on the line Subcontractor --> Main Contractor and Main Contractor --> Investor.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: Accounting for contractors and sub-contractors is important because the contractor's and subcontractor's contract prices may be different, and the terms of the contracts may also be different. It is therefore important that the ICT application keeps all data on quantities performed, approved, and invoiced throughout the contract cascade: subcontractor --> contractor --> investor.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application for the monthly billing of subcontractors work. Digitalisation level 4: Xpert, Axis
1		We recommend using a networked ICT application with multi-user capability for monthly subcontracting billing. Digitalisation level 4: Xpert, Axis
2		We recommend using a network application where users can enter actual quantities produced, approved quantities and invoiced quantities. Digitalisation level 4: Xpert, Axis
3		
4		You achieve the highest level of digitalisation for accounting for subcontracted work.

Change management

- **Question:** [20/39] Change management [weight 1,48%]
- **Additional information (for the "info" button)**: Changes to the project are defined as any deviation in the project from the subject matter of the contract and the financial and schedule provisions of the contract.
Changes shall be managed through stipulated process and documentation.
- **Answers with a short and a long version.**

Short answer	Long answer
0 No application	Digitalisation level 0 [0%] There is no dedicated application to collect data on project changes.
2 Network application for documenting changes	Digitalisation level 2 [60%] There is a dedicated application that provides network access to document changes to a project. The documentation for the changes is prepared manually in different software and in different files - documents.
3 Automatic documentation of changes based on BIM and priced BoQ	Digitalisation level 4 [100%] There is a dedicated application that provides network access to document changes to a project. The draft documentation for financial and time related changes is prepared automatically, so that before that the changes are recorded manually in the BIM models and in the priced BoQ and applications for the time schedule.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: Change management is the difference between planned and actual costs. Good change management means a profit, bad change management means a loss on the project. The key to change management is to describe the changes and determine the financial and schedule impact on the contract.
The changes shall be described in the plans and the bill of quantities. The financial impact shall be determined by construction calculation and the time impact by updating the time schedule.
In more advanced applications, changes can be recorded automatically based on changes in the BIM model and BoQ and Time schedule.
Documentation of the changes is made and accessed in the online project portal.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using a common data environment for the purpose of storing documentation on changes to the project. Digitalisation level 2: MS Sharepoint, Microsoft Digitalisation level 2: DMS Next, EBA
1		
2		The level of Digitalisation could be increased by an application that would automatically produce change documentation based on manual changes in the BIM model, time schedule and priced BoQ.
3		
4		You achieve the highest level of digitalisation for project change management.

Construction measurement book (quantities executed)

- **Question:** [21/39] Construction measurement book (quantities executed) [weight 1.85%]
- **Additional information (for the "info" button)**: The Construction measurement book is a clearly and transparently documented calculation of the quantities of work actually carried out for each item.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 Construction book on paper	Digitalisation level 0 [0%] The construction measurement book is the book of accountable measurements is produced by hand in physical form on paper in a single copy.
2 Application with manual calculation	Digitalisation level 2 [50%] The Construction measurement book is produced in the system in the Construction situation module, where each item is manually calculated in a transparent way, with a calculation of the executed quantities and a description of their location.
3 Application with manual capture of elements from the BIM model	Digitalisation level 3 [80%] Item quantities are defined in the application via the BIM model, by manually marking the executed BIM elements in the model, which the application can then convert into BoQ item quantities.
4 Application with automatic quantity capture	Digitalisation level 4 [100%] Item quantities are determined in the application via the BIM model, by using sensors around the site to evaluate actualy executed works in form of BIM elements produced, which the application is then able to automatically convert into BoQ item quantities.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The construction measurement book is the document used to prove the calculation of the quantity of work carried out by each accounting time period.
In the non-digitalised analogue mode, the calculation of quantities is made by reading measurements on the 2D drawings and calculating them on paper forms.
In more advanced applications, the calculation of quantities is documented in the application with the measurements and the clear location of the measurements (axis, floor, etc.).
In the most advanced systems, the work carried out is marked on the elements in the BIM model and automatically considered in the billing documents.
In the future, the automatic capture of completed works data, linked to BIM models, will automatically calculate quantities.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application that stores all the data on the monthly amount of work carried out. Digitalisation level 2: Xpert, Axis
1		
2		The level of digitalisation can be increased by an app where BIM elements are marked as executed and quantities are automatically calculated in the construction measurement book.
3		The level of digitization can be increased with a sensor data acquisition system and an application that converts the captured data into BIM elements and determines the level of execution for automatic calculation of quantities in measurement book.
4		You achieve the highest level of digitalisation for project change management.

Financial and time monitoring of the project

Project performance

- **Question:** [22/39] Project performance [weight 1,48%]
- **Additional information (for the "info" button)**: Project performance means determining the status of a project in terms of whether it is making a profit or a loss, taking into account the work actually carried out.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 performance not monitored	Digitalisation level 0 [0%] The performance of the project is not monitored.
1 Comparison of costs and revenues	Digitalisation level 1 [20%] The performance of the project is monitored in a dedicated application by comparing the monthly situation (project income) with the project costs (expenditure to suppliers of materials, equipment, vehicles, machinery, labour, etc.) in the form of an S-curve.
4 Earned value method	Digitalisation level 4 [100%] Project performance is monitored monthly using the earned value method. Project performance is monitored at the monthly cost level in an application that has data entered for planned value (contract planned quantities and contract prices), earned value (actual quantities and contract prices) and actual value (sum of all invoice values).

Additional question:

Which IT tool do you use to implement the content of the indicator?

Co-funded by the European Union
DIG-IN-KPI

REPORT

Additional information text: The performance of a project must consider the balance of planned and actual costs and revenues in relation to the work actually carried out, otherwise the results may be misleading. Performance can be seen from a graph of three curves, obtained by connecting the monthly values of costs: planned, earned and actual.
The planned value of costs is calculated as the product of the contracted planned quantities for that month and the contracted prices. The earned value is the product of the actual quantities and the contracted prices. The actual value is the sum of the values of all invoices.
The relative position of the three curves gives information on the loss or gain and the work ahead or behind schedule on the project relative to the work actually carried out.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application to track your performance on the project. Digitalisation level 4: Xpert, Axis
1		We recommend using an ICT networking application with a project performance report based on the earned value method. Digitalisation level 4: Xpert, Axis
2		
3		
4		You achieve the highest level of digitalisation for monitoring project performance.

Tracking activities in the time schedule

- **Question:** [23/39] Tracking activities in the time schedule [weight 1,72%]
- **Additional information (for the "info" button)**: Tracking activities in the time schedule means finding out the actual start and actual end of an activity and the percentage of progress on each activity on the cut-off time.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 No tracking	Digitalisation level 0 [0%] No tracking of the activities in the time schedule.
1 Manual start and end entry	Digitalisation level 1 [20%] The time schedule is tracked by manually entering the start and end of each activity in a dedicated application.
4 percent of realization on activities	Digitalisation level 4 [100%] Tracking the time schedule with the quotient between the earned and the forecast cost per activity.

Additional question:

Which IT tool do you use to implement the content of the indicator?

Co-funded by the European Union
DIG-IN-KPI

REPORT

Additional information text: Monitoring the progress of activities within the time schedule is important to identify delays in the project for corrective action to be taken.
The start and end date of the actual work on the activity shall be recorded by a manual entry on each activity.
If the activities in the time schedule and the BoQ items are linked, the ICT application can automatically track the percentage of work completed on each activity indirectly through monthly situations.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application to track the progress of individual project activities. Digitalisation level 1: MS Project, Microsoft Digitalisation level 4: Xpert, Axis
1		We recommend using an ICT application to track the progress of individual project activities in percentage terms. Digitalisation level 4: Xpert, Axis
2		
3		
4		Achieve the highest level of digitalisation for tracking activities in the project timeline

Comparison of planned and actual consumption by quantity and cost according to production resources

- **Question:** [24/39] Comparison of planned and actual consumption by quantity and cost according to production resources [weight 1.08%]
- **Additional information (for the "info" button)**: this is an analysis to determine the deviation between the planned-resource rate and the actual consumption of resources at the level of calculative resources.
The planned monthly consumption of resources can only be determined based on the construction calculation and prices of the calculative resources.
The actual consumption of the quantities of real resources and their prices is based on actual invoices.
The comparison of calculative and real resources depends on the definition of their links in the database.
- **Answers with a short and a long version.**

Short answer	**Long answer**
0 No comparison	Digitalisation level 0 [0%] No comparison is made between the planned and actual consumption of production resources.
2 Financial comparison only	Digitalisation level 2 [50%] It is only possible to compare costs at the level of a group of resources (e.g. concrete, excavation, embankments, rent of all formwork, consumption of all formwork, etc.).
4 Financial and quantitative comparison	Digitalisation level 4 [100%] It is possible to compare quantities and costs at the level of each calculative resource.

Additional question:

Which IT tool do you use to implement the content of the indicator?

Co-funded by the European Union

REPORT

Additional information text: The comparison of planned and actual consumption of productive resources is an in-depth, complementary analysis to be applied after the global variations identified by the Earned Value Method have been identified. The purpose of comparing planned and actual resource consumption is to identify the causes of anomalies in a project in more detail. When comparing cost groups, the problematic resource group is identified and then a comparison of the consumption of each individual resource within the resource group is undertaken.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application to compare the projected and actual use of resources on the project. Digitalisation level 4: Xpert, Axis
1		
2		We recommend using an ICT application to compare the estimated and actual consumption of each resource. Digitalisation level 4: Xpert, Axis
3		
4		You achieve the highest level of digitalisation for comparing the planned and actual production resources on a project.

Comparison of planned and actual use of resources per BoQ item (Work Orders)

- **Question:** [25/39] Comparison of planned and actual resource consumption per BoQ item (Work order) [Weight 1.08%]
- **Additional information (for the "info" button)**: This is an in-depth analysis to determine the deviation between the planned and actual consumption of production resources for each BoQ item at the level of calculative resources. The functionality of work orders is required for comparison. The work order shall identify the type of work by specifying appropriate BoQ item and the types and quantities of real resources to be actually consumed.
- **Answers with a short and a long version.**

Short answer	Long answer
0 No comparison	Digitalisation level 0 [0%] No comparison is made between planned and actual consumption on production resources for each item.
4 Comparison based on work orders and calculation	Digitalisation level 4 [100%] The actual use of real resources on the BoQ item is determined by work orders. The work order must identify the item and the actual consumption of physical resources (labour, materials, equipment, machinery). The shortfall of unallocated real resources from the invoices (end of month) must be distributed manually by dividing them into individual work orders.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The construction calculation and the BoQ and the construction monthly situation determine the resource rate planned consumption of the calculative resources of the BoQ item. The determination of the relationship between calculative resources and real resources constitutes the determination of the common denominator of the comparison of production resources.
The comparison of planned and actual consumption of productive resources for each item is an in-depth, complementary analysis to be applied after the global deviations identified by the earned value method have been established.
The comparison of planned and actual consumption of resources per item can be used for resource rate studies of work processes to develop more accurate resource rates or to identify in more detail the causes of anomalies in a project.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application to compare the planned and actual use of resources on an item. Digitalisation level 4: Xpert; Axis
1		
2		
3		
4		You achieve the highest level of digitalisation for comparing estimated and actual production resources per item.

Comparison of the planned and actual use of resources for each activity in the time schedule (work task)

- **Question:** [26/39] Comparison of planned and actual use of resources for each activity in the time schedule (Work order) [weight 1.08%]
- **Additional information (for the "info" button)**: This is an in-depth analysis to determine the deviation between the planned – resource rates and actual consumption of production resources for each activity in the time schedule at the level of calculative resources. The functionality of work orders is required for comparison. The work order shall identify the type of work by specifying the activity in the time schedule and quantities of real resources to be consumed. To determine the planned resource rates consumption of resources, a construction calculation for the BoQ must be made and there must be a link between BoQ items and activities in the schedule.
- **Answers with a short and a long version.**

Short answer	Long answer
0 No comparison	Digitalisation level 0 [0%] No comparison is made between the planned and actual consumption on the production resources for each activity in the time schedule.
4 Comparison based on work orders and calculation	Digitalisation level 4 [100%] Work Orders determine the actual use of real resources per activity in the time schedule. The work order should identify the activity in the time schedule and the actual consumption of real resources (labour, materials, equipment, machinery). The shortfall of unallocated physical resources from the accounts (end of month) should be done manually by splitting them into individual work orders.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The construction calculation and BoQ and the construction monthly situation and the link between the BoQ and the time schedule determine the resource rates planned consumption of calculative resources on the activities in the time schedule. The relationship between calculative resources and real resources constitutes the common denominator for the comparison of production resources.

The comparison of the planned and actual consumption of production resources for each activity in the time schedule is an in-depth, complementary analysis to be applied after the identification of global deviations, which are determined using the earned value method. The comparison of planned and actual resource consumption per activity can be used for resource rates studies of work processes, which can be used to develop more precise resource rate or to identify the causes of anomalies in the project in more detail.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application to compare the planned and actual use of resources on the activities in the time schedule.
1		
2		
3		
4		You achieve the highest level of digitalisation to compare forecast and actual production resources per activity in the time schedule.

Project progress report

- **Question:** [27/39] Project progress report [weight 1.72%]
- **Additional information (for the "info" button)**: The Project Progress Report provides basic financial and timing information on the progress of the project at the cut-off date. The report also includes more detailed analytics showing planned and actual costs by BoQ item. The report can be manually generated using the results of the application functionality or the application can generate the report automatically.
- **Answers with a short and a long version.**

Short answer	Long answer
0 No progress report	Digitalisation level 0 [0%] No project progress report is produced.
1 Manualy made for global indicators	Digitalisation level 1 [30%] The user can manually generate a report for the global project performance indicators using the application's functionalities (S-curve, comparison of planned and consumed resources, time schedule tracking)
2 Automatic creation for global indicators	Digitalisation level 2 [50%] The application can automatically generate a report for global project performance indicators based on its functionalities (S-curve, comparison of planned and consumed resources, time schedule tracking)
3 Manualy made for global indicators and detailed analytics	Digitalisation level 3 [70%] Using the application's functionalities, the user can manually generate a report for global performance indicators (S-curve, comparison of planned and consumed resources, time schedule tracking) and detailed project analytics on planned and actual costs for deviated BoQ items.
4 Automatic creation for global indicators and detailed analytics	Digitalisation level 4 [100%] The app's functionalities can automatically produce a report for global performance indicators (S-curve, comparison of planned and consumed resources, time schedule tracking) and detailed project analytics on planned and actual costs for deviated BoQ items.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: To define a report that alerts the user to critical deviations in the project, it is necessary to have functionalities and data that process information on production resources, finances, and time schedule.
The report consists of global project performance indicators and detailed project analytics. The global project performance indicators are:
- S curve using the earned value method,
- Comparison of the planned resource rates consumption and the actual consumption of resources,
- a time schedule showing the planned contractual and actual progress of activities.

Detailed project analysis compares planned and actual resources by BoQ item.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using an ICT application to produce a progress report on the project. Digitalisation level 1: Xpert, Axis
1		We recommend an app that can automatically produce a project progress report with global project performance indicators.
2		We recommend an application that can be used to produce global project performance indicators and detailed project analytics.
3		We recommend an app that can automatically produce global project performance indicators and detailed project analytics.
4		Achieve the highest level of digitalisation for project progress reports.

Business management

Business Information System

- **Question:** [28/39] Business Information System [weight 6.77%]
- **Additional information (for the "info" button)**:

The Business Information System covers areas common to all companies:
- receiving and issuing invoices
- payroll,
- ordering and
- storage records.

Having a single application reduces the chance of errors in data processing and transmission.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No business information system	Digitalisation level 0 [0%] There is no app for business data.
1 Several different applications	Digitalisation level 1 [20%] For the functionalities: - receiving and issuing invoices - payroll, - ordering and - storage records, exists 4 applications without links and common databases.
2 Two stand-alone applications with no associated databases	Digitalisation level 2 [50%] For the functionalities: - receiving and issuing invoices - payroll, - ordering and - storage records, exists no more than 2 applications without links and shared databases
3 Two stand-alone applications with linked databases	Digitalisation level 3 [70%] For the functionalities: - receiving and issuing invoices - payroll, - ordering and - storage records, there are no more than 2 applications with links and shared databases.
4 One application	Digitalisation level 4 [100%] There is one application for invoicing, payroll, ordering and warehouse management.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: A business information system processes information that is part of the business world. It makes sense to use an ICT tool that covers as much functionality as possible to allow data exchange within the application.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using a project information system for business process management. Digitalisation level 4: Pantheon, Datalab Digitalisation level 4: Synesis-Ofir
1		We recommend using no more than two ICT applications for business process management. Digitalisation level 4: Pantheon, Datalab Digitalisation level 4: Synesis-Ofir
2		We recommend using no more than two ICT applications with common databases to manage your business processes. Digitalisation level 4: Pantheon, Datalab Digitalisation level 4: Synesis-Ofir
3		We recommend using one IT system to manage your business processes. Digitalisation level 4: Pantheon, Datalab Digitalisation level 4: Synesis-Ofir
4		You achieve the highest level of digitalisation for business process management.

E-commerce

- **Question:** [29/39] E-commerce [weight 6,77%]
- **Additional information (for the "info" button)**:

E-commerce covers the electronic preparation, issuing, sending, receipt and storage of business documents such as contracts, invoices, delivery notes, receipts, ...

- **Answers with a short and a long version.**

Short answer	Long answer
0 Paper documents	Digitalisation level 0 [0%] Documents shall be prepared, send, and archived in physical paper form. They shall be signed by hand. The data for documents shall be entered manually in the Business Information System.
1 Documents are scanned	Digitalisation level 1 [20%] Physical documents are scanned, emailed, and stored digitally (pfd, doc, jpg) on local disks. The data for documents is entered manually in the Business Information System.
2 Documents in the EDI standard	Digitalisation level 2 [40%] Documents for which there is an EDI standard (e.g., e-slog) are produced in electronic format (xml), sent via email and stored on local disks. The data for the documents is manually imported into the Business Information System.
3 Application for the EDI standard	Digitalisation level 3 [80%] Documents are produced in electronic xml format (various EDI standards) in a cloud-based e-commerce platform. E-documents are only exchanged within the platform over secure path networks. The platform on the receiving end can convert the sender's document into a format that is readable by the receiving end, provided that the e-document is produced using an EDI standard. E-documents are classified by content and access and are stored in the cloud. The e-commerce platform contains an e-register of companies, banks, public administrations that have e-commerce support with e-readers that allow the receipt and review of e-documents.
4 Application for the EDI standard integrated into the ERP system	Digitalisation level 4 [100%] The e-commerce platform is integrated into the business information system. All pre-existing documents are digitalised and integrated into a common networked cloud-based e-document repository.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: E-commerce standardises the data needed to document business events and simplifies the secure exchange of data. Lower levels of Digitalisation are characterised by document scanning and manual data entry. In more advanced levels of digitalisation, documents are used according to the EDI standard. Platforms are used whereby the sender produces a document and sends it via secure e-routes to the address, who can read it using their own application. Data no longer needs to be copied or entered manually. The highest level of digitalisation is an application integrated into the business information system.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend using the e-commerce platform. Digitalisation level 3: DMS Next, EBA Digitalisation level 4: BizBox, ZZI
1		We recommend using an e-commerce platform to generate documents in a standardised format. Digitalisation level 3: DMS Next, EBA Digitalisation level 4: BizBox, ZZI
2		We recommend using an e-commerce platform to send documents through secure channels and store documents in the cloud. Digitalisation level 3: DMS Next, EBA Digitalisation level 4: BizBox, ZZI
3		We recommend using an e-commerce platform that will be integrated into your business system. Digitalisation level 4: BizBox, ZZI
4		Achieving the highest level of digitalisation for e-commerce

Master data code for workers, vehicles, machinery, and equipment

- **Question:** [30/39] Master data code for workers, vehicles, machinery, and equipment [weight 6,77%]
- **Additional information (for the "info" button)**:

A single database for working assets and workers is a prerequisite for data processing. It is a database containing all physical working assets and a named list of workers. The master data code gives unique reference number to the working assets and workers.

- **Answers with a short and a long version.**

Short answer	**Long answer**
0 No master code	Digitalisation level 0 [0%] There is no master data code for workers, machinery, and equipment.
2 Master code for workers or machinery	Digitalisation level 2 [40%] There is a master data code only for workers or only for machinery.
4 Master code for workers and machinery	Digitalisation level 4 [100%] A single database that defines a unique master code for each entity (worker, vehicle, machine, work asset).

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The master data code gives unique reference number to all production resources. The master data code for workers, machinery, vehicles and equipment are used for the tracking of the value of the enterprise, for ordering and invoicing purposes. The use of uniform master data code lists eliminates the risk of substantive differences in interpretation.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you establish uniform master data coding lists for workers, machinery, vehicles, and other equipment.
1		
2		We recommend that you define all the unique master data code lists for machinery, vehicles, and other equipment.
3		
4		You achieve the highest level of digitalisation for master data code lists for workers, machinery, vehicles, and equipment.

Real resources

- **Question:** [31/39] Real resources [weight 5.85%]
- **Additional information (for the "info" button)**:

It is a database for resources (materials, machinery, vehicles, equipment, labour) used in procurement, warehousing, and accounting. The resources are recorded with technical data that do not change with time and space. Names of real resources must not contain commercial names. Unit of measurement for real resources should correspond to units of measurement of products that can be bought. One calculative resource represents one or more real resources. One real resource can represent several commercial resources which have different commercial names but have the same technical properties.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No database	Digitalisation level 0 [0%] There is no common database for accounting, warehousing, and procurement of production resources.
1 Combination of real and commercial resources	Digitalisation level 1 [20%] There is a common database for accounting and warehousing, but it is a combination of real and commercial resources in one database.
2 Database of real resources for half the scope of the company	Digitalisation level 2 [60%] There is a common database of real resources. The database contains data for at least half of the scope of work carried out by the enterprise and has an administrator in charge of updating the descriptions and prices of real resources.
3 Database of real resources linked to commercial resources for half of the scope of the company's activities	Digitalisation level 3 [80%] There is a common database of real resources. There are links between real and commercial resources in the database. The database contains data for at least half of the works carried out by the company and has an administrator in charge of updating the descriptions and prices of the real resources.
4 database of real resources linked to commercial resources for the entire scope of the company's activities	Digitalisation level 4 [100%] There is a common database of real resources. There are links between real resources and commercial resources in the database. The database contains data for all areas of work carried out by the company and has an administrator in charge of updating the descriptions and prices of real resources.

Additional question:

Which database do you use to implement the content of the indicator?

REPORT

Additional information text:

The resources are named with technical data that does not change with time and space. Names of real resources must not contain commercial names. Unit of measurement for real resources should correspond to units of measurement of products that can be bought.

The real resources are important because they form an intermediate link between the calculative resources and the commercial resources and master data code lists. Ideally, they should contain resources covering all areas of the company's activities. To ensure data integrity, it is a good idea to have a single administrator for the real resource data base. To compare planned and actual consumed resources, it is also necessary that the links between real and calculative resources are defined.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you establish a realistic resource base.
1		We recommend that you define your resource base in such a way that the descriptions of the resources are technical and not commercial and that you appoint a custodian.
2		We recommend that you establish a link between the real resources database and the costing resources database.
3		We recommend that you set up a database of real resources for the entire scope of work covered by your company.
4		You are achieving the highest level of Digitalisation for the database of real resources.

Commercial resources

- **Question:** [32/39] Commercial resources [weight 2,59%]
- **Additional information (for the "info" button)**:

It is database for resources (materials, machinery, vehicles, equipment) used in procurement, warehousing, and accounting records. One real resource with technical name may have several adequate commercial resources with commercial names. Commercial resources have commercial names from supplier and manufacturer. That is the reason they only exist in a certain period in a certain area. Users are more familiar with the commercial name, than with the technical name of real resource, because they are buying products with commercial names. User may choose from array of different commercial resources with different prices which technically correspond to one real resource.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No commercial resource database	Digitalisation level 0 [0%] There is no commercial resource database.
1 Combination of real and commercial resources	Digitalisation level 1 [20%] There is a common database for accounting and warehousing, but it is a combination of real (technical designation only) and commercial (commercial designation only) resources in one database.
2 commercial resource base for half the size of the company	Digitalisation level 2 [60%] There is a common database of commercial resources. The database contains data for at least half of the work carried out by the company and has an administrator in charge of keeping the descriptions and prices of commercial resources up to date.
3 base of commercial resources linked to real resources for half of the scope of the company's activities	Digitalisation level 3 [80%] There is a common database of commercial resources. There are links between real and commercial resources in the database. The database contains data for at least half of the works carried out by the company and has an administrator in charge of updating the descriptions and prices of commercial resources.
4 database of commercial resources linked to real resources for the entire scope of the company's activities	Digitalisation level 4 [100%] There is a common database of commercial resources. The database contains data for all the work carried out by the company and has an administrator in charge of keeping the descriptions and prices of commercial resources up to date.

Additional question:

Which database do you use to implement the content of the indicator?

REPORT

Additional information text: Commercial resources are important for the unambiguous procurement of products, because sometimes a technical description of real resource is not enough. Commercial resources are also important to verify which real resource correspond to the commercial resource that user desires. User can then select from all commercial resources that correspond to real resource, the one which is the cheapest.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you make a commercial resource data base.
1		We recommend that you define the commercial resource base by making the commercial descriptions of the commercial resources and appoint an administrator.
2		We recommend that you establish link between the real resources database and the commercial resources database.
3		We recommend that you set up a database of commercial resources for the entire scope of work covered by your company.
4		You achieve the highest level of digitalisation for a commercial resource base.

Worker's status by worksite

- **Question:** [33/39] Workers by worksite [weight 2,22%]
- **Additional information (for the "info" button)**:

Recording the number and type of workers by worksite is essential for efficient workforce allocation.

- **Answers with a short and a long version.**

Short answer	Long answer
0 Status is not monitored	Digitalisation level 0 [0%] The status of workers by worksite is not monitored.
1 Manual weekly collection of information	Digitalisation level 1 [10%] There are named lists of workers and the location of the workplaces where they are based. The list is updated manually on a weekly basis by all worksite managements and sent to the person who collects the worksite data for whole company.
2 Manual weekly updating on the server	Digitalisation level 2 [40%] There are named lists of workers and the location of the workplaces where they are based. The list is updated manually weekly in one place so that it is filled in by all site managements on the web server.
4 Automatic daily status monitoring	Digitalisation level 4 [100%] Each worker is identified by a code when arriving and leaving the worksite each day. Their presence is automatically read and recorded in the time and attendance system and is valid for payroll purposes. The application shows daily: the list of workers by name, the number of workers, the type of workers and their qualifications, their attendance, and the reason for absence for each worksite.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: Effective workforce management requires daily monitoring of the number and qualifications of workers at worksite locations. This enables management to effectively allocate the workforce across worksites to the places where it is most needed. The highest level of digitalisation of the status of workers on a worksite is the automatic recording of the time of arrival and departure of a worker on a worksite. The automatic jobsite recording system is linked to the workers' master data code and is also used for payroll.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you monitor the status of workers at each worksite.
1		We recommend that the list of workers is updated in one place on the server by the site managers.
2		We recommend that you set up a system to automatically record working time as workers arrive and leave the worksite.
3		
4		You achieve the optimal level of digitalisation for monitoring the status of workers on worksites.

Vehicle and machine tracking (sensors and remote reading)

- **Question:** [34/39] Condition of vehicles and machinery (sensors and remote reading) [weight 0,92%]
- **Additional information (for the "info" button)**:

Vehicles and machinery shall be equipped with sensors for fuel status, mass load and location. The data collected by the sensors is transmitted wirelessly to a central server.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No vehicle tracking	Digitalisation level 0 [0%] There is no tracking of vehicles and machinery.
1 One sensor: fuel, mass, location	Digitalisation level 2 [30%] Each vehicle and machine is equipped with one of the fuel status, mass load or satellite location sensors and a system to communicate the data to a central server.
3 Two sensors: fuel, mass, location	Digitalisation level 3 [60%] Each vehicle and machine is equipped with two of the sensors for fuel status, mass load or satellite location status, and a system to communicate the data to a central server.
4 three sensors: fuel, mass, location	Digitalisation level 4 [100%] Each vehicle and machine is equipped with sensors for fuel status, mass load and satellite location status, and a system to communicate the data to a central server.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: An automatic satellite tracking system is used to efficiently track vehicles and machinery. The actual lengths and locations of journeys are recorded for the vehicles. The location of vehicles and machines is reported at specific time intervals or when the vehicle or machine moves. In this way, the company also has greater control against theft of vehicles and machinery. In the case of machinery, in addition to the working hours, the location of the working machinery by work site is also obtained. If vehicles and machines also have fuel consumption sensors, this helps to increase the reliability of the resource rate and to discover theft of fuel. Trucks, on the other hand, may have mass load sensors to determine vehicle efficiency and resource rates consumption.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you equip your vehicles and machinery with sensors to monitor satellite location, fuel status and mass load. Digitalisation level 3: Easy tracker, Bent Excellent Digitalisation level 3: Sledat, Uscom Digitalisation level 3: Altron, Digitalisation level 4: Sledenje.com, Sledenje
1		
2		We recommend that you equip your vehicles and machinery with all the sensors needed to monitor satellite location, fuel status and mass load. Digitalisation level 3: Easy tracker, Bent Excellent Digitalisation level 3: Sledat, Uscom Digitalisation level 3: Altron, Digitalisation level 4: Sledenje.com, Sledenje
3		We recommend that you equip your vehicles and machinery with all the sensors needed to monitor satellite location, fuel status and mass load. Digitalisation level 4: Sledenje.com, Sledenje
4		You achieve the optimal level of digitalisation for tracking vehicles and machines.

Work orders

- **Question:** [35/39] Work Orders [weight 1,94%]
- **Additional information (for the "info" button)**:

A work order is a functionality that defines the actual purpose or the actual consumption of production resources in a technological process. Production resources are material, labour, vehicles, machinery, equipment. Technological processes are defined as items in the work BoQ and as activities in the time schedule.

- **Answers with a short and a long version.**

Short answer	Long answer
0 No work orders	Digitalisation level 0 [0%] Work orders are not used.
1 Manual entry for 3 resource types	Digitalisation level 1 [30%] Actual consumption by BoQ item and time schedule activity is manually entered into the web application as real resources for at least 3 types of resources (material, labour, machinery, vehicles).
2 Manual entry for 5 types of sources	Digitalisation level 2 [50%] Actual consumption by BoQ item and time schedule activity is manually entered into the web application as real resources for all 5 types of resources (material, labour, machinery, vehicles, equipment).
3 Scan codes for 3 types of sources	Digitalisation level 3 [80%] The actual consumption by item and activity for at least 3 types of resources (material, labour, machinery, vehicles, equipment) is entered into the network application by scanning codes from the master data code.
4 Scan codes for 5 types of sources	Digitalisation level 4 [100%] The actual consumption by item and activity for all 5 types of resources (material, labour, machinery, vehicles, equipment) is entered into the network application by scanning codes from the master code lists.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: A work order is a statement of the actual consumption of production resources (material, labour, machinery, vehicles, equipment, etc.) on the work processes defined for the BoQ items and for the activity in the time schedule.
At a lower level of digitalisation, production resources are entered manually from the real resources database and master data code, while at a higher level of digitalisation, production resources are entered by scanning codes. The data from the master code lists must be paired with the data from the real resources database. The master data from the work orders shall be used to match the data from the real resources code list. The real resources are used to produce project performance reports based on a comparison of the planned and actual consumption of production resources.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend you choose an ICT application with work order functionality. Digitalisation level 2: Xpert, Axis
1		We recommend that you choose an ICT application with work order functionality and databases for all areas of production resources. Digitalisation level 2: Xpert, Axis
2		We recommend that you choose an ICT application with work order functionality with the ability to scan codes from master data code.
3		We recommend that you choose an ICT application with work order functionality with the ability to scan codes from master data code for all areas of production resources.
4		You achieve the optimal level of digitalisation for your work tasks.

Establishing production resource requirements

- **Question:** [36/39] Establishing production resource requirements [weight 2,22%]
- **Additional information (for the "info" button)**:

For larger companies, establishing production resource requirements is essential for strategic planning of production resources at the level of the whole company.
The requirements for material, labour and machinery must have a time component so that the quantity and interval for hiring or purchasing production resources can be planned.

- **Answers with a short and a long version.**

Short answer	Long answer
0 Communication of requirements by e-mail	Digitalisation level 0 [0%] Requests from individual construction sites for workers and machinery are collected at a central point by phone or email.
1 Automatic display of requirements for 2 types of resources	Digitalisation level 1 [40%] Display of production resource requirements data for databases for 2 resource types (material, labour, machinery, vehicles, equipment) for any resource and any time interval for all worksites in the company.
2 Automatic display of requirements for 3 types of resources	Digitalisation level 2 [60%] Display of production resource requirements data for databases for 3 resource types (material, labour, machinery, vehicles, equipment) for any resource and any time interval for all worksites in the company.
3 Automatic display of requirements for 4 types of resources	Digitalisation level 3 [80%] Display of production resource requirements data for databases for 4 resource types (material, labour, machinery, vehicles, equipment) for any resource and any time interval for all worksites in the company.
4 Automatic display of requirements for 5 types of resources	Digitalisation level 4 [100%] Display of production resource requirements data for databases for all 5 resource types (material, labour, machinery, vehicles, equipment) for any resource and any time interval for all worksites in the company.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: The planning of production resource requirements is done at the level of calculative resources. Plans are made for any precise unit of time (month, week, day) and for each significant calculative resource. Prerequisite for systematic and analytical planning of calculative resources is construction calculation and the time scheduling, which must be linked.
The final objective is to establish the temporal dynamics of the production resource requirements for the company as a whole and to determine when and how much of external resources needs to be rented and to establish the dynamics of material resource procurement for company as a whole.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you choose an ICT application that allows you to show your production resource requirements based on a construction calculation and a time schedule. Digitalisation level 4: Xpert, Axis
1		We recommend that you choose an ICT application that allows you to show the requirements for production resources based on construction calculation and time scheduling for more types of resources. Digitalisation level 4: Xpert, Axis
2		We recommend that you choose an ICT application that allows you to show the requirements for production resources based on construction calculation and time scheduling for more types of resources. Digitalisation level 4: Xpert, Axis
3		We recommend that you choose an ICT application that allows you to show the requirements for production resources based on a construction calculation and a time schedule for all types of resources. Digitalisation level 4: Xpert, Axis
4		You achieve the optimal level of digitalisation for establishing production resource requirements.

Procurement of production resources

- **Question:** [37/39] Procurement of production resources [weight 2.49%]
- **Additional information (for the "info" button)**:

Procurement of production resources is a business event in which the site manager orders materials, labour, vehicles, machinery, equipment for work on a project from the purchasing department of the Company. The level of Digitalisation is higher when:
- using a networked ordering application,
- using uniform database for production resources,
- keeping clients informed about the progress of the order and delivery,
- using e-documents,
- managing procurement with a central purchasing service.

- **Answers with a short and a long version.**

Short answer	Long answer
0 By e-mail	Digitalisation level 0 [0%] Ordering of materials, workers and machinery is done without using a central network application, by sending orders by email, verbally by phone or fax.
1 Application without code books	Digitalisation level 1 [30%] Use of a network application for ordering production resources without the use of uniform databases for production resources.
2 Application with code books	Digitalisation level 2 [60%] Use of a network application for ordering production resources and use of uniform database for production resources.
3 Application with code books and notifications	Digitalisation level 3 [80%] Use of a network application for ordering production resources and - use of uniform databases for production resources - information on the progress of the order and delivery
4 Application with code books, notification and e-documents	Digitalisation level 4 [100%] Use of all four production resource ordering functionalities: - use of a networked ordering application, - use of uniform databases for production resources, - information on the progress of the order and delivery, - use of e-documents

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: In the procurement of production resources, a higher level of digitalisation means using a networked application to access and transmit data in real time.
A higher level of digitalisation also means using uniform databases for procurement: real resources and commercial resources, to avoid mis procurement.
A higher level of digitalisation also means centralised publication of information on business transactions regarding order receipt, order cancellation and order delivery.
The use of e-documents also represents a higher level of digitalisation, due to the reduction of manual data entry and simplified data exchange.
A higher level of organisation means a centralised procurement department so that greater discounts can be realised through economies of scale.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you choose a networked ICT application that allows you to order production resources.
1		We recommend that you set up uniform database for ordering production resources.
2		We recommend that you set up order progress information from the supplier to the client.
3		We recommend that you use EDI standard documents for production resource orders.
4		You achieve an optimal level of digitalisation for the procurement of production resources.

Tendering procedure for subcontractors

- **Question:** [38/39] Tendering procedure for subcontractors [weight 2,46%]
- **Additional information (for the "info" button)**:

For craftwork and workforce providers the main contractor must carry out a request for quotations from subcontractors.
The works relating to a subcontractor must be excluded from the BoQ made for the whole project. The BoQs for subcontractors works shall be forwarded by the main contractor to the subcontractors for them to enter their tender prices. The main contractor shall compare the tenders of the subcontractors and select the most advantageous one.

- **Answers with a short and a long version.**

Short answer	Long answer
0 Paper bid	Digitalisation level 0 [0%] The works to be subcontracted are manually selected and marked from the BoQ and manually sent to the subcontractors. They return priced BoQ manually completed. The documents are in scanned form.
1 Bid in xls	Digitalisation level 1 [20%] The subcontracted works are manually selected in an xls file. The exchange of documents for the request for quotation and the quotation shall take place by e-mail. The subcontractor shall manually fill in the prices and return them in xls format.
2 Application for dividing the BoQ and file export	Digitalisation level 2 [40%] Using a network invoicing application that allows: - subdivision of the BoQ into subcontracting lots, - export of the subcontract BoQ lot to subcontractors.
3 Application for import and export of parts of BoQ and comparison of bids	Digitalisation level 4 [100%] Using a network invoicing application that allows: - subdivision of the BoQ into subcontracting lots, - export of the subcontract BoQ lot to subcontractors, - export of activities from the schedule to subcontractors, - importing the subcontractor's priced BoQ lot, - comparison of subcontracting lots for the same works.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: subcontractors make up a large part of the project works, so it is important that the tendering process is also transparent and documented. Advanced stages of digitalisation include the use of network application for subcontracting tendering procedures and the following functionalities:
- subdivision of the BoQ into subcontracting lots,
- export of the subcontractor BoQ lot to subcontractors,
- export of subcontractor's activities from the time schedule to subcontractors,
- importing the subcontractor's BoQ lot with prices,
- comparison of subcontractors lots.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you choose network application that allows tendering out works to subcontractors. 4 Digitalisation levels: Xpert, Axis
1		We recommend that you choose an ICT network application that allows you to split the BoQ into subcontracting lots and export the subcontracting lots to subcontractors. Digitalisation level 4: Xpert, Axis
2		We recommend that you choose a network ICT application that, in addition to splitting the BoQ and exporting the subcontracting lot, allows you to import subcontracting bids and compare the same subcontracting lot with different subcontractor's bids. Digitalisation level 4: Xpert, Axis
3		
4		You achieved the optimum level of digitalisation for tendering out work to subcontractors.

Storage management

- **Question:** [39/39] Storage managements [weight 2,15%]
- **Additional information (for the "info" button)**:

Storage managements is the monitoring of stocks by warehouse. In larger companies, there are central warehouses by department (formwork plant, ironworks plant, concrete plant, asphalt plant, etc.) and warehouses for individual work sites.

- **Answers with a short and a long version.**

Short answer	Long answer
0 Paper cards	Digitalisation level 0 [0%] Records of materials and equipment are filled in manually on paper cards.
1 Files on network drives	Digitalisation level 1 [30%] The records of materials and equipment are filled in xls files located on network drives.
2 Network application with code books and manual selection	Digitalisation level 2 [60%] Records for materials and equipment are kept in a dedicated network application using a common database of real resources and commercial resources. Entries are made by manual entry and selection in databases.
4 Network application with code books and code scanning	Digitalisation level 4 [100%] Receipt of materials and equipment is recorded by warehouse by scanning the codes on delivery notes. Consumption of materials in the warehouse is recorded by entry in digital work orders.

Additional question:

Which IT tool do you use to implement the content of the indicator?

REPORT

Additional information text: Storage management of warehouse is meant to control the consumption of materials and the use of equipment. The lower level of digitalisation uses uniform databases of real and commercial resources and manual recording of stocks. The higher level of digitalisation uses scanning of delivery note codes for warehouse receipts and manual entry of material consumption in digital work orders to reduce storage stocks on worksites. Recording of material consumption is also used for project performance to compare planned and consumed production resources.

	Short answer from the questionnaire (used in the MADM model)	**Recommendations for the user in the report based on the selected answer**
0		We recommend that you choose a networked ICT application to manage your warehouse stock. Digitalisation level 2: Synesis-Ofir
1		We recommend that you use the common database for real resources and commercial resources to record warehouse stocks in the ICT network application. Digitalisation level 2: Synesis-Ofir
2		We recommend that you upgrade the uniform databases in the network application to enable code scanning for delivery notes and dispatch notes from the warehouse.
3		
4		You achieve the optimal level of digitalisation for your storage management.

DIG-IN-KPI AAT report

Company: TestniJaka

Date: 14.3.2024

Contents

1 Foreword....4
2 Summary by area / display only....6
3 Report....7
3.1 Digital transformation....7
3.1.1 Digitalisation strategy....7
3.1.2 Introducing a digital culture in your company....7
3.2 Project management....8
3.2.1 Project Information System....8
3.2.2 Web portal and common data environment....8
3.2.3 Construction diary....9
3.2.4 Weather data recording....9
3.3 Bill of Quantities....10
3.3.1 Format of the priced Bill of Quantities....10
3.3.2 Text description of works in BoQ item....11
3.3.3 Quantity for BoQ item....11
3.3.4 Making of BoQ....12
3.3.5 Contractor's lots....13
3.4 Financial evaluation....13
3.4.1 Calculative resources....13
3.4.2 Construction calculation and database for resource consumption rates....14
3.4.3 Database of past project BoQ items....14
3.5 Time scheduling....15
3.5.1 Time schedule....15
3.5.2 Linking BoQ items and activities in the Time schedule....15
3.5.3 Linking elements from the BIM model and activities from the time schedule....16
3.6 Billing....17
3.6.1 Calculation of monthly situations (billing quantities)....17
3.6.2 Accounting for co-contractors and sub-contractors....17
3.6.3 Change management....18
3.6.4 Construction measurement book (quantities executed)....19
3.7 Financial and time monitoring of the project....20
3.7.1 Project performance....20
3.7.2 Tracking activities in the time schedule....20
3.7.3 Comparison of planned and actual consumption by quantity and cost according to production resources....21
3.7.4 Comparison of planned and actual use of resources per BoQ item (Work Orders)....21
3.7.5 Comparison of the planned and actual use of resources for each activity in the time schedule (work task)....22
3.7.6 Project progress report....23
3.8 Business management....24
3.8.1 Business Information System....24
3.8.2 E-commerce....24
3.8.3 Master data code for workers, vehicles, machinery, and equipment....25
3.8.4 Real resources....25

3.8.5 Commercial resources....26
3.8.6 Worker's status by worksite....26
3.8.7 Vehicle and machine tracking (sensors and remote reading)....27
3.8.8 Work orders....28
3.8.9 Establishing production resource requirements....28
3.8.10 Procurement of production resources....29
3.8.11 Tendering procedure for subcontractors....30
3.8.12 Storage management....31
4 Methodology for determining the degree of digitalization....32
5 Financing statement....34

1 Foreword

We thank you for the information provided during the self-assessment of the digitization of your construction contractor company.

In the following, you will find a report with an assessment of digitization in the areas of: digital transformation, project management, bill of quantities, financial evaluation, time scheduling, Billing of construction works, financial and time monitoring of projects, and business management, which is made especially for your company.

The report contains for each indicator your assessment of current state, a graphic display of the percentage of digitization for each indicator, an additional explanation of the indicator and a list of recommendations with which you can further improve your digitization.

We are convinced that the report is an important milestone for your company, with which you will get a basic insight into the current state and level of maturity of the digitization of your contractor construction company and fundamental information about the possible next steps on your digital transformation journey.

You will also be able to use the tool later to monitor and measure your progress in digitizing your project and business processes.

We will promote the online digitization evaluator especially among the countries of the Balkan region, among the former republics of the Yugoslavia, with which we shared the same views on the management of construction projects. Therefore, it is useful to identify and analyse problems that are common to all and offer answers to increase the competitiveness of our companies.

At the conclusion of the project DIG AND KPI, expected in May 2024, we will also produce a summary report in which we will present the state of digitization of construction contractors in Slovenia, Croatia and Macedonia. The report will also include an indication and self-assessment of the level of digitization achieved according to indicators for applications and digital tools used by our contractor companies. Digitization indicators will also be promoted within the framework of the Construction 4.0 working group, the umbrella organization of the construction industry employers FIEC, based in Brussels, which also supports and promotes digitization projects in the construction sector approved by various programs of the European Commission.

We invite you to visit the websites of the involved organizations and learn about the current information

regarding the digital maturity and digital transformation of construction companies. Digitalization indicators for construction contractors were developed in the joint project DIG IN KPI of the chambers of commerce from Slovenia (GZS ZGIGM), Croatia (HKG) and Macedonia (MKCHAMBER) and professional support from company AXIS from Ljubljana. The project is co-financed by the European Union through the Erasmus+ program.

2 Summary by area / display only

The degree of digitalization is calculated taking into account the achieved levels of digitalization of all indicators of the field on a 5-point scale from 1 to 5, namely your company has achieved the following results:

1. **Digital transformation:**
   - Current rating: 2/5
   - Expected status in 3 years: 3/5
2. **Project management:**
   - Current status: 3/5
   - Expected status in 3 years: 4/5
3. **Bill of Quantities:**
   - Current rating: 4/5
   - Expected status in 3 years: 4/5
4. **Financial evaluation:**
   - Current rating: 4/5
   - Expected status in 3 years: 5/5
5. **Time scheduling:**
   - Current rating: 3/5
   - Expected status in 3 years: 5/5
6. **Billing:**
   - Current rating: 4/5
   - Expected status in 3 years: 5/5
7. **Financial and time monitoring of the project:**
   - Current rating: 4/5
   - Expected status in 3 years: 5/5
8. **Business management:**
   - Current rating: 4/5
   - Expected status in 3 years: 5/5

The overall level of digitization of your company:

- Current status: **4/5**
- Expected situation in 3 years: **5/5**

3 Report

3.1 Digital transformation

3.1.1 Digitalisation strategy

Answer:

Digitalisation level 2 [50%]: The company analysed the digitalisation measures from a cost perspective and selected specific equipment to increase digitalisation.

Additional information:

The Digitalisation strategy depends on the company's management structures. Awareness of the importance of digitising project and business processes is essential for quality and efficient business management. A digitalisation strategy includes both modern ICT tools and the databases used by the ICT tools.

Recommendation:

After purchasing ICT equipment, we advise you to analyse whether you will provide the appropriate databases to work with ICT tools by purchasing from vendors or developing them in-house.

3.1.2 Introducing a digital culture in your company

Answer:

Digitalisation level 2 [50%]: The company has organised training for all employees who have undergone changes to their work due to the introduction of digitalisation.

Additional information:

Implementing a digital culture in a company starts with identifying the actual and necessary knowledge to work effectively with new ICT tools. It continues with training. Employee acceptance of digitalisation is then measured by identifying job satisfaction and performance, and is promoted through additional training.

Recommendation:

After the training, we advise you to carry out surveys to measure your satisfaction and effectiveness with the new ICT tools.

3.2 Project management

3.2.1 Project Information System

Answer:

Digitalisation level 1 [30%]: A dedicated BoQ and project accounting application is used, which is installed on a local computer. Data is exchanged by sending files between computers.

Additional information:

The application is essential for managing the data that enables effective project management. The application allows for the creation of Bills of Quantities, cost estimation of BoQ items, monthly project billing, scheduling and project performance analytics.

The better applications enable team working, multiple users on a common database and data stored in the cloud rather than on local computers. Better applications also have the ability to manage production resources on an enterprise-wide level, as a project portfolio of individual projects.

Recommendation:

We recommend you choose a networked ICT application for construction project management. Digitalisation level 3: Xpert, Axis.

3.2.2 Web portal and common data environment

Answer:

Digitalisation level 0 [0%]: Documents are exchanged between participants via e-mail. Documents are stored on users' local drives.

Additional information:

A web portal that allows project documents to be stored in one place improves the quality of data, as key information is collected and accessed in one place only. This avoids incorrect and outdated versions of project documentation, while providing users with the fastest possible access to documents as soon as they are published by the producer. Better applications have hierarchical access to data according to the roles of users on the project.

Recommendation:

We recommend you choose an ICT tool for a common data environment. Digitalisation level 4: Sharepoint, Microsoft. Digitalisation level 4: DMS Next, EBA. Digitalisation level 4: Dalux Box Pro.

3.2.3 Construction diary

Answer:

Digitalisation level 3 [80%]: The construction diary is filled in daily in a cloud-based system with a personal password. Each entry shall record the identity of the entrant and the time of entry. Only the current day may be entered. Retrospective corrections are not possible. By checking and digitally signing, the persons responsible shall confirm that they are aware of the information in the construction logbook.

Additional information:

A construction diary is a document that describes the progress of construction and is used by the various participants in the construction process to inform each other of important findings by making entries. More advanced construction diary tools allow the automatic identity of the entrant and the entry for the current day only. The most advanced tools allow automatic suggestions for the entry of work progress and site status.

Recommendation:

We recommend choosing an ICT tool for the construction logbook that automatically enters data on site work and weather based on data already entered in work orders and weather sensors.

3.2.4 Weather data recording

Answer:

Digitalisation level 4 [100%]: Weather sensors devices automatically record weather data for temperature, humidity, wind and precipitation for each hour in a file.

Additional information:

Capturing weather data is useful for demonstrating construction constraints due to rain, snow, cold, heat and for demonstrating conditions that may affect the quality of construction, such as concrete care. With automatic logging, data can be read at shorter time intervals, giving more accurate and reliable data.

Recommendation:

You achieve the highest level of Digitalisation for capturing weather data.

3.3 Bill of Quantities

3.3.1 Format of the priced Bill of Quantities

Answer:

Digitalisation level 0 [0%]: There are no rules on the format of BoQ. The data for an BoQ item is not in one line. The BoQ is prepared in multiple tabs in Excel files. Hence the data must be further processed (define WBS, merge rows, problem of multiple units of measurement and quantities within one item) if the data are to be imported into the BoQ application. The summation of areas and recapitulation is done manually using the cell summation formula.

Additional information:

The format of Priced BoQ and Unpriced BoQ is very important for data exchange. How the data is organised is important when importing and exporting data. If it is not known which data is important and where can be read, it is necessary to manually correct the data for importing. It is therefore necessary that the data exchange file for the inventory has a standardised format.

Recommendation:

We recommend that you choose any ICT application for editing BoQ. Any IT inventory management application can only work if it has standardised data. BoQ data format will automatically be standardized when exporting BoQ from ICT application for editing BoQ.

3.3.2 Text description of works in BoQ item

Answer:

Digitalisation level 4 [100%]: There is a database of standardised data that can be used to create standardised BoQ item text for a project. With such a database, theoretically millions of different items can be created for one technological process (e.g. concrete slab).

Additional information:

The quality of the text description of works in an item has a significant impact on the price of the item and consequently on the contract value. The quality of the item text description is greatly increased if a standardised database for item text descriptions is used. The accuracy of the item text description is increased if the number of data is sufficiently large to take into account all significant price influences.

Recommendation:

You achieve the highest level of Digitalisation for the quality of the description of the works in the item.

3.3.3 Quantity for BoQ item

Answer:

Digitalisation level 3 [60%]: The quantities for the BoQ items are produced manually, but in the BoQ application, so that there are pre-estimates. There is a clear traceability in the application of how the calculation of quantities has been made, so that the location on the object for each measurement in the calculation can be seen. The location reference is described by linking the BoQ item to the elements in the BIM model from which the formula quantities are calculated.

Additional information:

The calculation of quantities for BoQ items has a significant impact on the price of the item and consequently on the contract value.

Transparency and clarity are important when calculating quantities so that the calculation can be verified. This means that the location of the elements and the dimensions from which they are calculated are clearly visible.

A less advanced way is to use special QTO (quantity take off) applications to calculate areas, lengths and count pieces based on 2D plans.

However, the concept of linking elements in the 3D model and items of the BoQ is considered to be more advanced. The location can be described in words or with BIM elements. The highest level of Digitalisation is the automatic calculation of quantities directly for each BoQ item from the BIM model.

Recommendation:

We recommend that you choose an ICT application that allows you to calculate quantities for BoQ items from automatic measurements in the BIM model.

3.3.4 Making of BoQ

Answer:

Digitalisation level 4 [100%]: A dedicated network application is used to produce standardised BoQ based on a standard BoQ database and a 3D BIM model. For most BoQ items, a description of the works and a calculation of quantities are automatically produced based on the standard database and the 3D BIM model.

Additional information:

In less sophisticated applications, only one cost engineer can work on a BoQ and the BoQ is produced sequentially by type of works. Or many cost engineer are working on many parts of BoQ on separate files and all the files that comprise BoQ are after completion merged together. In more advanced applications, however, several BoQ makers may be working on the same BoQ at the same time so that there is less risk of duplication of items. In this case, everyone concerned has a real-time view of the creation of the whole BoQ which is being created. The highest level of Digitalisation is represented by the automatic production of a standardised bill of quantities based on a standardised database and a 3D BIM model.

Recommendation:

You achieve the highest level of Digitalisation to create an BoQ of works.

3.3.5 Contractor's lots

Answer:

Digitalisation level 2 [30%]: Use a programme where the files are separate: a.) Exporting tender file for subcontractors, b.) Importing tender files from subcontractors. and c.) Importing the invoice file for subcontractor. The software allows to upload the tender files of subcontractors where tenders can be compared.

Additional information:

The lowest level of Digitalisation is where separate files are for subcontractor inquiry, quotation and invoicing, which need to be processed separately in a local programme. A higher level of Digitalisation means using a network application into which files also need to be imported and exported, which are sent by email, but the data is then stored and accessed centrally in one place. The highest form of Digitalisation is the use of a network application on which all users work, each with their own level of hierarchical access rights and data is stored in central place.

Recommendation:

We recommend you choose a more advanced networked ICT tool that allows you to access all subcontracting data in one place. Digitalisation level 4: Xpert, Axis.

3.4 Financial evaluation

3.4.1 Calculative resources

Answer:

Digitalisation level 3 [80%]: There is a common unified database of calculative resources. The database defines the link between calculative and real resources. The database contains all construction works and has an administrator in charge of updating the descriptions and prices of costing resources.

Additional information:

The calculative resource database is a database used to estimate the price of works and to plan the consumption of production resources and costs at the level of project processes. One calculative resource can represent one or

more of the real resources.

A prerequisite for a quality database is the assignment of a database administrator to keep the resource descriptions and prices up to date. Better Digitalisation means resource coverage for as large a range of works as possible within the company. A higher level of digitalisation means linking project and business codebooks or linking calculative and real resources.

Recommendation:

We recommend that you extend your database of costing resources to all the areas covered by your company.

3.4.2 Construction calculation and database for resource consumption rates

Answer:

Digitalisation level 3 [80%]: The calculation uses a database of parameterised process consumption rates, where the resource consumption can be fine-tuned by changing the parameters.

Additional information:

Construction calculation means assigning resources to BoQ items. A prerequisite for the rapid calculation is the existence of a database of process's consumption rates. Low level digitalisation means a list of process's consumption rates where the parameters are described in the process's consumption rates description. A higher level of digitalisation is represented by a database of parameterised process's consumption rates where parameters can be adjusted. The highest level of digitalisation is the automatic selection of resource rates and resources according to the BoQ item description.

Recommendation:

We recommend using a system that allows automated calculation based on the item description.

3.4.3 Database of past project BoQ items

Answer:

Digitalisation level 2 [50%]: There is a database of BoQ items from past projects. The user can manually search for similar items by part or whole of the item description, unit of measurement with the aim of extracting BoQ items with prices and dates for past projects.

Additional information:

The database of past projects is a useful functionality of an ICT application if it can be used to query prices. A lower level of Digitalisation is achieved by manual queries of the database using filters. A higher level is achieved by automated suggestions of similar items and automatic consideration of prices which consider contemporary market situation.

Recommendation:

You can achieve a higher level of digitalisation by integrating AI that will select the best approximations to your BoQ items from a database of past projects.

3.5 Time scheduling

3.5.1 Time schedule

Answer:

Digitalisation level 2 [50%]: Creating a time schedule in a dedicated application that allows activities to be linked.

Additional information:

Time schedule is the document that defines the activities of the project. Activities should be selected on a location basis so that planned and actual progress can be compared. The ICT application used to produce the time schedule must be able to identify the interdependencies between activities and to define the critical path of activities. A time schedule is also essential for the systematic and integrated production resource plan and a financial plan.

Recommendation:

We recommend using an ICT application to produce critical path time schedules. Digitalisation level 4: MS Project, Microsoft. Digitalisation level 4: Tilos.

3.5.2 Linking BoQ items and activities in the Time schedule

Answer:

Digitalisation level 2 [50%]: An activity in the time schedule can be linked to an item in the BoQ in such a way that one item can be linked to one or more activities, or one activity can be linked to one or more items. In this case, the items have only prices and only a financial plan can be made.

Additional information:

The linking of the BoQ items and activities in the time schedule is essential for the systematic preparation of the resource and financial plan. For the financial plan, only the pricing of the items is necessary. For the resource plan, a construction calculation with resources is necessary.

The linking of BoQ items and activities allows for immediate changes to the resource and financial plans if the duration of the activities in the time schedule changes.

Recommendation:

We recommend using an ICT application that allows you to link the BoQ items and the activities in the time schedule, both for prices and resources. Digitalisation level 4: Xpert, Axis.

3.5.3 Linking elements from the BIM model and activities from the time schedule

Answer:

Digitalisation level 4 [100%]: The BIM model elements and the activities in the schedule are linked directly or indirectly by linking the BIM elements to the items and the items to the activities in the schedule.

Additional information:

Direct linking of BIM elements and activities in the time schedule is used in the BIM application. The practical application is a visual representation of the construction sequence. With this link, financial plans can be produced in BIM applications if the values of the elements are specified, or resource plans if resources are linked to the elements. However, practice shows that financial and resource plans with BIM applications are of poorer quality because they do not have well-developed construction calculation functionalities, nor do they have the necessary databases for resources.

Recommendation:

You achieve the highest level of digitalisation to link the BIM model and the schedule.

3.6 Billing

3.6.1 Calculation of monthly situations (billing quantities)

Answer:

Digitalisation level 4 [100%]: Monthly situations are produced in a dedicated network application that stores data for all monthly situations. It is possible to enter several quantities for each BoQ item: executed quantity (contractor) and approved quantity (supervisor) and invoiced quantity regarding contract specifications. The quantities for the items are calculated manually and entered into the application manually.

Additional information:

The monthly situations billing is one of the most important tasks on the project. Therefore, the data must be clear and transparent. The advantage is if it is produced in a networked application that can be accessed by everyone concerned of billing. It should also be clear where the contractor and the supervisor stand on the quantities carried out and how much is approved according to the form of the contract.

Recommendation:

You achieve the highest level of digitalisation for the billing of works carried out.

3.6.2 Accounting for co-contractors and sub-contractors

Answer:

Digitalisation level 2 [40%]: Monthly situations are produced in a dedicated network application that stores data for monthly situations. The system only allows the tracking of one quantity number, and it is not clear whether the number relates to actual quantities performed, approved quantities or invoiced quantities by month for each subcontractor on the project. The BoQ item's prices and accounting terms in the same project may be different depending on the relations of the subcontractor-contractor and contractor-investor, so the situations must be treated separately on the line Subcontractor --> Main Contractor and Main Contractor --> Investor.

Additional information:

Accounting for contractors and sub-contractors is important because the contractor's and subcontractor's contract prices may be different, and the terms of the contracts may also be different. It is therefore important that the ICT application keeps all data on quantities performed, approved, and invoiced throughout the contract cascade: subcontractor --> contractor --> investor.

Recommendation:

We recommend using a network application where users can enter actual quantities produced, approved quantities and invoiced quantities. Digitalisation level 4: Xpert, Axis.

3.6.3 Change management

Answer:

Digitalisation level 4 [100%]: There is a dedicated application that provides network access to document changes to a project. The draft documentation for financial and time related changes is prepared automatically, so that before that the changes are recorded manually in the BIM models and in the priced BoQ and applications for the time schedule.

Additional information:

Change management is the difference between planned and actual costs. Good change management means a profit, bad change management means a loss on the project. The key to change management is to describe the changes and determine the financial and schedule impact on the contract.

The changes shall be described in the plans and the bill of quantities. The financial impact shall be determined by construction calculation and the time impact by updating the time schedule.

In more advanced applications, changes can be recorded automatically based on changes in the BIM model and BoQ and Time schedule.

Documentation of the changes is made and accessed in the online project portal.

Recommendation:

You achieve the highest level of digitalisation for project change management.

3.6.4 Construction measurement book (quantities executed)

Answer:

Digitalisation level 3 [80%]: Item quantities are defined in the application via the BIM model, by manually marking the executed BIM elements in the model, which the application can then convert into BoQ item quantities.

Additional information:

The construction measurement book is the document used to prove the calculation of the quantity of work carried out by each accounting time period.

In the non-digitalised analogue mode, the calculation of quantities is made by reading measurements on the 2D drawings and calculating them on paper forms.

In more advanced applications, the calculation of quantities is documented in the application with the measurements and the clear location of the measurements (axis, floor, etc.).

In the most advanced systems, the work carried out is marked on the elements in the BIM model and automatically considered in the billing documents.

In the future, the automatic capture of completed works data, linked to BIM models, will automatically calculate quantities.

Recommendation:

The level of digitization can be increased with a sensor data acquisition system and an application that converts the captured data into BIM elements and determines the level of execution for automatic calculation of quantities in measurement book.

3.7 Financial and time monitoring of the project

3.7.1 Project performance

Answer:

Digitalisation level 4 [100%]: Project performance is monitored monthly using the earned value method. Project performance is monitored at the monthly cost level in an application that has data entered for planned value (contract planned quantities and contract prices), earned value (actual quantities and contract prices) and actual value (sum of all invoice values).

Additional information:

The performance of a project must consider the balance of planned and actual costs and revenues in relation to the work actually carried out, otherwise the results may be misleading. Performance can be seen from a graph of three curves, obtained by connecting the monthly values of costs: planned, earned and actual.

The planned value of costs is calculated as the product of the contracted planned quantities for that month and the contracted prices. The earned value is the product of the actual quantities and the contracted prices. The actual value is the sum of the values of all invoices.

The relative position of the three curves gives information on the loss or gain and the work ahead or behind schedule on the project relative to the work actually carried out.

Recommendation:

You achieve the highest level of digitalisation for monitoring project performance.

3.7.2 Tracking activities in the time schedule

Answer:

Digitalisation level 4 [100%]: Tracking the time schedule with the quotient between the earned and the forecast cost per activity.

Additional information:

Monitoring the progress of activities within the time schedule is important to identify delays in the project for corrective action to be taken.

The start and end date of the actual work on the activity shall be recorded by a manual entry on each activity.

If the activities in the time schedule and the BoQ items are linked, the ICT application can automatically track the percentage of work completed on each activity indirectly through monthly situations.

Recommendation:

Achieve the highest level of digitalisation for tracking activities in the project timeline.

3.7.3 Comparison of planned and actual consumption by quantity and cost according to

Answer:

Digitalisation level 4 [100%]: It is possible to compare quantities and costs at the level of each calculative resource.

Additional information:

The comparison of planned and actual consumption of productive resources is an in-depth, complementary analysis to be applied after the global variations identified by the Earned Value Method have been identified. The purpose of comparing planned and actual resource consumption is to identify the causes of anomalies in a project in more detail. When comparing cost groups, the problematic resource group is identified and then a comparison of the consumption of each individual resource within the resource group is undertaken.

Recommendation:

You achieve the highest level of digitalisation for comparing the planned and actual production resources on a project.

3.7.4 Comparison of planned and actual use of resources per BoQ item (Work Orders)

Answer:

Digitalisation level 0 [0%]: No comparison is made between planned and actual consumption on production

resources for each item.

Additional information:

The construction calculation and the BoQ and the construction monthly situation determine the resource rate planned consumption of the calculative resources of the BoQ item. The determination of the relationship between calculative resources and real resources constitutes the determination of the common denominator of the comparison of production resources.

The comparison of planned and actual consumption of productive resources for each item is an in-depth, complementary analysis to be applied after the global deviations identified by the earned value method have been established.

The comparison of planned and actual consumption of resources per item can be used for resource rate studies of work processes to develop more accurate resource rates or to identify in more detail the causes of anomalies in a project.

Recommendation:

We recommend using an ICT application to compare the planned and actual use of resources on an item. Digitalisation level 4: Xpert; Axis.

3.7.5 Comparison of the planned and actual use of resources for each activity in the time

Answer:

Digitalisation level 4 [100%]: Work Orders determine the actual use of real resources per activity in the time schedule. The work order should identify the activity in the time schedule and the actual consumption of real resources (labour, materials, equipment, machinery). The shortfall of unallocated physical resources from the accounts (end of month) should be done manually by splitting them into individual work orders.

Additional information:

The construction calculation and BoQ and the construction monthly situation and the link between the BoQ and

the time schedule determine the resource rates planned consumption of calculative resources on the activities in the time schedule. The relationship between calculative resources and real resources constitutes the common denominator for the comparison of production resources.

The comparison of the planned and actual consumption of production resources for each activity in the time schedule is an in-depth, complementary analysis to be applied after the identification of global deviations, which are determined using the earned value method. The comparison of planned and actual resource consumption per activity can be used for resource rates studies of work processes, which can be used to develop more precise resource rate or to identify the causes of anomalies in the project in more detail.

Recommendation:

You achieve the highest level of digitalisation to compare forecast and actual production resources per activity in the time schedule.

3.7.6 Project progress report

Answer:

Digitalisation level 3 [70%]: Using the application's functionalities, the user can manually generate a report for global performance indicators (S-curve, comparison of planned and consumed resources, time schedule tracking) and detailed project analytics on planned and actual costs for deviated BoQ items.

Additional information:

To define a report that alerts the user to critical deviations in the project, it is necessary to have functionalities and data that process information on production resources, finances, and time schedule.

The report consists of global project performance indicators and detailed project analytics. The global project performance indicators are:

- S curve using the earned value method,
- comparison of the planned resource rates consumption and the actual consumption of resources,
- a time schedule showing the planned contractual and actual progress of activities.

Detailed project analysis compares planned and actual resources by BoQ item.

Recommendation:

We recommend an app that can automatically produce global project performance indicators and detailed project analytics.

3.8 Business management

3.8.1 Business Information System

Answer:

Digitalisation level 3 [70%]: For the functionalities: a.) receiving and issuing invoices, b.) payroll, c.) ordering, and d.) storage records, there are no more than 2 applications with links and shared databases.

Additional information:

A business information system processes information that is part of the business world. It makes sense to use an ICT tool that covers as much functionality as possible to allow data exchange within the application.

Recommendation:

We recommend using one IT system to manage your business processes. Digitalisation level 4: Pantheon, Datalab. Digitalisation level 4: Synesis-Ofir.

3.8.2 E-commerce

Answer:

Digitalisation level 4 [100%]: The e-commerce platform is integrated into the business information system. All pre-existing documents are digitalised and integrated into a common networked cloud-based e-document repository.

Additional information:

E-commerce standardises the data needed to document business events and simplifies the secure exchange of data. Lower levels of Digitalisation are characterised by document scanning and manual data entry. In more advanced levels of digitalisation, documents are used according to the EDI standard. Platforms are used whereby

the sender produces a document and sends it via secure e-routes to the address, who can read it using their own application. Data no longer needs to be copied or entered manually. The highest level of digitalisation is an application integrated into the business information system.

Recommendation:

Achieving the highest level of digitalisation for e-commerce.

3.8.3 Master data code for workers, vehicles, machinery, and equipment

Answer:

Digitalisation level 4 [100%]: A single database that defines a unique master code for each entity (worker, vehicle, machine, work asset).

Additional information:

The master data code gives unique reference number to all production resources. The master data code for workers, machinery, vehicles and equipment are used for the tracking of the value of the enterprise, for ordering and invoicing purposes. The use of uniform master data code lists eliminates the risk of substantive differences in interpretation.

Recommendation:

You achieve the highest level of digitalisation for master data code lists for workers, machinery, vehicles, and equipment.

3.8.4 Real resources

Answer:

Digitalisation level 3 [80%]: There is a common database of real resources. There are links between real and commercial resources in the database. The database contains data for at least half of the works carried out by the company and has an administrator in charge of updating the descriptions and prices of the real resources.

Additional information:

The resources are named with technical data that does not change with time and space. Names of real resources must not contain commercial names. Unit of measurement for real resources should correspond to units of measurement of products that can be bought.

The real resources are important because they form an intermediate link between the calculative resources and the commercial resources and master data code lists. Ideally, they should contain resources covering all areas of the company's activities. To ensure data integrity, it is a good idea to have a single administrator for the real resource data base. To compare planned and actual consumed resources, it is also necessary that the links between real and calculative resources are defined.

Recommendation:

We recommend that you set up a database of real resources for the entire scope of work covered by your company.

3.8.5 Commercial resources

Answer:

Digitalisation level 4 [100%]: There is a common database of commercial resources. The database contains data for all the work carried out by the company and has an administrator in charge of keeping the descriptions and prices of commercial resources up to date.

Additional information:

Commercial resources are important for the unambiguous procurement of products, because sometimes a technical description of real resource is not enough. Commercial resources are also important to verify which real resource correspond to the commercial resource that user desires. User can then select from all commercial resources that correspond to real resource, the one which is the cheapest.

Recommendation:

You achieve the highest level of digitalisation for a commercial resource base.

3.8.6 Worker’s status by worksite

Answer:

Digitalisation level 4 [100%]: Each worker is identified by a code when arriving and leaving the worksite each day. Their presence is automatically read and recorded in the time and attendance system and is valid for payroll purposes. The application shows daily: the list of workers by name, the number of workers, the type of workers and their qualifications, their attendance, and the reason for absence for each worksite.

Additional information:

Effective workforce management requires daily monitoring of the number and qualifications of workers at worksite locations. This enables management to effectively allocate the workforce across worksites to the places where it is most needed. The highest level of digitalisation of the status of workers on a worksite is the automatic recording of the time of arrival and departure of a worker on a worksite. The automatic jobsite recording system is linked to the workers' master data code and is also used for payroll.

Recommendation:

You achieve the optimal level of digitalisation for monitoring the status of workers on worksites.

3.8.7 Vehicle and machine tracking (sensors and remote reading)

Answer:

Digitalisation level 3 [60%]: Each vehicle and machine is equipped with two of the sensors for fuel status, mass load or satellite location status, and a system to communicate the data to a central server.

Additional information:

An automatic satellite tracking system is used to efficiently track vehicles and machinery. The actual lengths and locations of journeys are recorded for the vehicles. The location of vehicles and machines is reported at specific time intervals or when the vehicle or machine moves. In this way, the company also has greater control against theft of vehicles and machinery. In the case of machinery, in addition to the working hours, the location of the working machinery by work site is also obtained. If vehicles and machines also have fuel consumption sensors, this helps to increase the reliability of the resource rate and to discover theft of fuel. Trucks, on the other hand, may have mass load sensors to determine vehicle efficiency and resource rates consumption.

Recommendation:

We recommend that you equip your vehicles and machinery with all the sensors needed to monitor satellite location, fuel status and mass load. Digitalisation level 4: Sledenje.com, Sledenje.

3.8.8 Work orders

Answer:

Digitalisation level 3 [80%]: The actual consumption by item and activity for at least 3 types of resources (material, labour, machinery, vehicles, equipment) is entered into the network application by scanning codes from the master data code.

Additional information:

A work order is a statement of the actual consumption of production resources (material, labour, machinery, vehicles, equipment, etc.) on the work processes defined for the BoQ items and for the activity in the time schedule.

At a lower level of digitalisation, production resources are entered manually from the real resources database and master data code, while at a higher level of digitalisation, production resources are entered by scanning codes. The data from the master code lists must be paired with the data from the real resources database. The master data from the work orders shall be used to match the data from the real resources code list. The real resources are used to produce project performance reports based on a comparison of the planned and actual consumption of production resources.

Recommendation:

We recommend that you choose an ICT application with work order functionality with the ability to scan codes from master data code for all areas of production resources.

3.8.9 Establishing production resource requirements

Answer:

Digitalisation level 4 [100%]: Display of production resource requirements data for databases for all 5 resource types (material, labour, machinery, vehicles, equipment) for any resource and any time interval for all worksites

in the company.

Additional information:

The planning of production resource requirements is done at the level of calculative resources. Plans are made for any precise unit of time (month, week, day) and for each significant calculative resource. Prerequisite for systematic and analytical planning of calculative resources is construction calculation and the time scheduling, which must be linked.

The final objective is to establish the temporal dynamics of the production resource requirements for the company as a whole and to determine when and how much of external resources needs to be rented and to establish the dynamics of material resource procurement for company as a whole.

Recommendation:

You achieve the optimal level of digitalisation for establishing production resource requirements.

3.8.10 Procurement of production resources

Answer:

Digitalisation level 4 [100%]: Use of all four production resource ordering functionalities: a.) use of a networked ordering application, b.) use of uniform databases for production resources, c.) information on the progress of the order and delivery, d.) use of e-documents.

Additional information:

In the procurement of production resources, a higher level of digitalisation means using a networked application to access and transmit data in real time.

A higher level of digitalisation also means using uniform databases for procurement: real resources and commercial resources, to avoid mis procurement.

A higher level of digitalisation also means centralised publication of information on business transactions

regarding order receipt, order cancellation and order delivery.

The use of e-documents also represents a higher level of digitalisation, due to the reduction of manual data entry and simplified data exchange.

A higher level of organisation means a centralised procurement department so that greater discounts can be realised through economies of scale.

Recommendation:

You achieve an optimal level of digitalisation for the procurement of production resources.

3.8.11 Tendering procedure for subcontractors

Answer:

Digitalisation level 4 [100%]: Using a network invoicing application that allows: a.) subdivision of the BoQ into subcontracting lots, b.) export of the subcontract BoQ lot to subcontractors, c.) export of activities from the schedule to subcontractors, d.) importing the subcontractor's priced BoQ lot, and e.) comparison of subcontracting lots for the same works.

Additional information:

Subcontractors make up a large part of the project works, so it is important that the tendering process is also transparent and documented. Advanced stages of digitalisation include the use of network application for subcontracting tendering procedures and the following functionalities:

- subdivision of the BoQ into subcontracting lots,
- export of the subcontractor BoQ lot to subcontractors,
- export of subcontractor’s activities from the time schedule to subcontractors,
- importing the subcontractor's BoQ lot with prices,
- comparison of subcontractors lots.

Recommendation:

You achieved the optimum level of digitalisation for tendering out work to subcontractors.

3.8.12 Storage management

Answer:

Digitalisation level 2 [60%]: Records for materials and equipment are kept in a dedicated network application using a common database of real resources and commercial resources. Entries are made by manual entry and selection in databases.

Additional information:

Storage management of warehouse is meant to control the consumption of materials and the use of equipment. The lower level of digitalisation uses uniform databases of real and commercial resources and manual recording of stocks. The higher level of digitalisation uses scanning of delivery note codes for warehouse receipts and manual entry of material consumption in digital work orders to reduce storage stocks on worksites. Recording of material consumption is also used for project performance to compare planned and consumed production resources.

Recommendation:

We recommend that you upgrade the uniform databases in the network application to enable code scanning for delivery notes and dispatch notes from the warehouse.

4 Methodology for determining the degree of digitalization

For each digitization indicator, an impact weight and a benefit weight are determined.

The impact weight is determined by determining how much impact the process described by the indicator has on different departments in the company. Services in the company are company administration, operational implementation of projects, commercial sales department, engineering for subcontracting works, technical preparation of projects, accounting department, purchasing department, warehouses, personnel department, warehouses, machinery and equipment.

The impact weight for an indicator is the sum of the impacts of all services on the process described by the indicator.

The impact of the ponders on the field service can be categorized as follows:

- Impact Level 2: the service uses the process directly by changing values or using data from the database.
- Impact Level 1: the service examines the values, but does not intervene directly in the process.
- Impact Level 0: the service does not read or review and has no connection to the process.

The determination of benefit weight is based on the usefulness or the necessity of the functionality that the indicator describes. Here are the factors impacting the determination of benefit weight:

- Benefit Weight 18-20: functionality necessary for the operation of a construction company.
- Benefit Weight 14-17: functionality necessary for the good business of a construction company.
- Benefit Weight 10-13: functionality is recommended, but not necessary.
- Benefit Weight 6-9: functionality has a smaller impact on the operations of the construction company.
- Benefit Weight 1-5: the functionality has no impact on the operations of the construction company.

For each indicator of the level of digitization of the construction contractor, a global unique weight (weight) in % was determined for the purpose of the DIG IN KPI ATT tool. The global weight of the indicator is calculated as a proportional share of the product of the weight of the impact and the weight of the benefit against the sum of the products of the weight of the impact and the benefit of all indicators.

Digitization rates with a local weight in % are determined for each indicator. The user self-evaluates which level

of digitization they are achieving based on the description of the level of digitization.

The level of digitization of the area is calculated from the entered levels of digitization of the user (local weights) and certain levels of global weights that apply to the indicators in the area.

DEX methodology

The core of the advanced online tool for obtaining an assessment of a company's digital maturity level is based on a multi-criteria decision-making methodology (DEX - decision expert methodology), which enables the evaluation, analysis, and comparison of individual SMEs. The problem of evaluating an individual SME can be treated as a multi-criteria decision problem, where we must map the characteristics of an individual company into a state assessment.

The DEX methodology relies on the decomposition of a complex problem into smaller, manageable subproblems. The decomposition is represented by a hierarchical tree of attributes. The final evaluation of the alternative (company) is derived by combining the values of the basic attributes towards the root of the tree with utility functions represented in the form of simple "if-then" rules. Unlike a linearly weighted sum, rules can capture non-linearities in decision knowledge and are human-understandable. Qualitative stores of value are represented by descriptive (natural) attribute values. A hierarchical tree of attributes, a set of decision rules (criterion functions) is defined by an expert or a group of experts and represents a knowledge base.

5 Financing statement

The information and views set out in this tool are those of the authors and do not necessarily reflect the official opinion of the European Union or European Education and Culture Executive Agency (EACEA). The European Union or EACEA do not guarantee the accuracy of the data included in this study. Neither the European Union or EACEA nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein.

Project ref. 2022-1-SI01-KA210-VET-000083218