Artificial Intelligence Application in Agile Transport Project Management

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Abstract. Project management in transport is a complex and dynamic process that is associated with several calculations and analysis of possible scenarios for the development of transport infrastructures. This is inevitably related to the need for rapid planning and identification of possible options, as well as to the need for a powerful tool for flexible planning management through which to support the teams involved in this planning. The features of the Agile methodology for project management are discussed. The advantages of using this methodology in the field of transport project management are considered. The aim of the paper is to point out the functional necessity and utility of Artificial Intelligence (AI) application in the Agile transport project management. Research in this study shows that Artificial Intelligence (AI) enabled project management is very promising.

Keywords. Artificial Intelligence, Agile Methodology, Flexible planning management, Agile project management, Transport infrastructure

1. Introduction

Modern world development includes fast and accurate delivery of people, goods and other transport services to society [1]. Although transport as a whole is a conservative sector in terms of security and safety, new technologies are rapidly entering it, and in some aspects even lagging behind in their development and implementation [2].

The planning and management of projects in the transport sector is a complex and dynamic process that is related to several calculations, as well as an analysis of possible scenarios for the development of transport infrastructure, rolling stock, etc. [3] The dynamic time in which we live requires planning time to be minimized, which is inevitably related to the need for quick planning and determining possible options [4].

The advent of flexible planning in project management, as well as the need for a new and more powerful tool through which these activities are carried out necessitates

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the use of modern information technologies [5]. Research in this area shows that Artificial Intelligence (AI) enabled project management is very promising [6, 7].

It is known that in modern software there are built-in functionalities that help the project manager to quickly draw up his scheme or plan for making his decision, but the evaluation and analysis of the correctness of the decision remains primarily the task of man. Artificial intelligence in project management can be widely used in risk assessment, analysis of budget and resource use, analysis of the work of teams, support management decision-making, etc. [8].

On the other hand, project managers usually manage a package of projects at the same time, which makes this activity even more complex. The artificial intelligence application in management of packages from projects can intensify efforts and automate this process as well [7].

The aim of the paper is to point out the functional necessity and utility of Artificial Intelligence (AI) application in the Agile transport project management. General concepts in transport project management are described. The features of the Agile methodology for project management are discussed. The advantages of using this methodology in the field of transport project management are considered.

2. The Essence of Transport Project Management

2.1. General Concepts in Transport Project Management

In general, the transport projects can comprise the construction or expansion of roads, highways, bridges, railways, airports, ports, subway systems, development of public transportation, implementation of intelligent transportation systems, and other similar activities. The essence of transport project management can be defined as the management and coordination of projects related to the development, modernization or improvement of transport infrastructure, services and systems. It is a complex and multilateral process through which it is intended to ensure efficiency, transparency and successful completion of projects. Transport project management includes planning, organizing, implementing and controlling the processes related to the development and implementation of projects in the field of transport [2, 4].

The well-known traditional approach [1, 9] through which the transport planning process goes involves the following steps:

- Monitoring the current state of the transport system.
- Population change forecasting and land use.
- Study of current transport problems and possible future ones.
- Develop a plan for transporting people and cargo.
- Environmental assessment of transport infrastructure.
- Development of a financial plan for the implementation of the planned transport changes.

Here, the planned development of a transport infrastructure is presented as four-stage model (Fig. 1) [2].
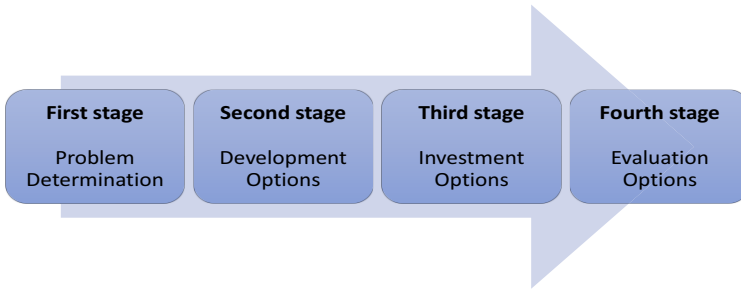
Figure 1. A fourth-stage model for transport infrastructure development.

The modernized version of the four-stage transport infrastructure planning model requires planning, which is made based on long-term forecasts of expected traffic using the mathematical models [4]. An extended four-stage model is shown in Figure 2.
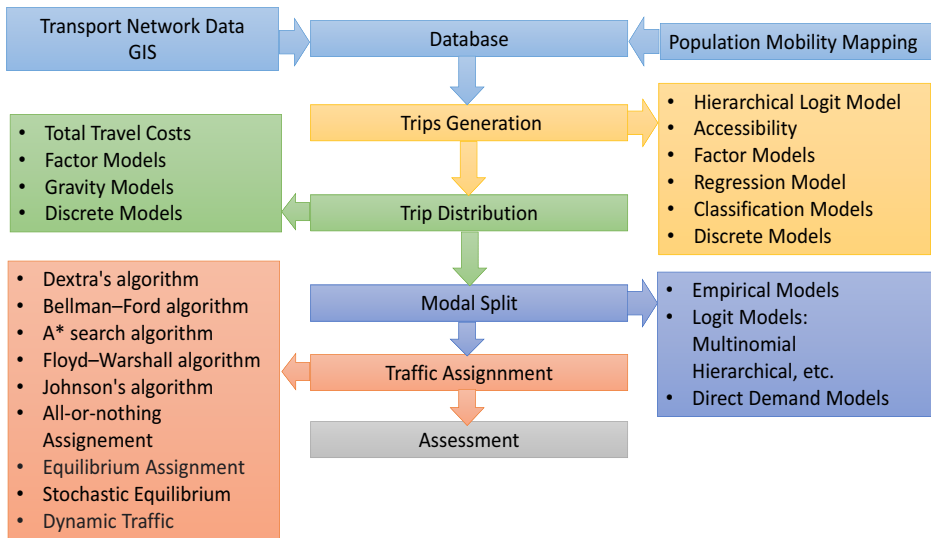

Figure 2. An extended four-stage model.

2.2. Agile Transport Project Management

Trends in strategic planning are for flexible (adaptive) [3] planning. The flexibility allows constant evaluation of the results and adjustment if necessary in order to achieve strategic objectives.

The stages of strategic transport planning are:

- Setting strategic objectives for transport development
- Analysis of the existing transport network
- Transport demand forecast for passenger and freight transport
- Justification of the projects included in the strategy
- Selection of scenarios including transport infrastructure projects for implementation

The Agile approach, which is traditionally used in the software industry, is also used in other areas of life, especially in transport projects, as these projects become more complex and fixed over time. A typical example is also its use in infrastructure transport projects [10, 11].

The Agile project management substantially differs from classical Waterfall approach, which consists of five stages (Requirements, Design, Implementation, Verification, and Maintenance).

The main specific features of the Agile approach are as follows:

- Project developers actively participate in the implementation and management of all stages of the project;
- All members of the project team have the right to make operational decisions to improve the performance of activities;
- During project implementation, some of the parameters may change, but it is recommended that the milestone deadlines remain fixed.

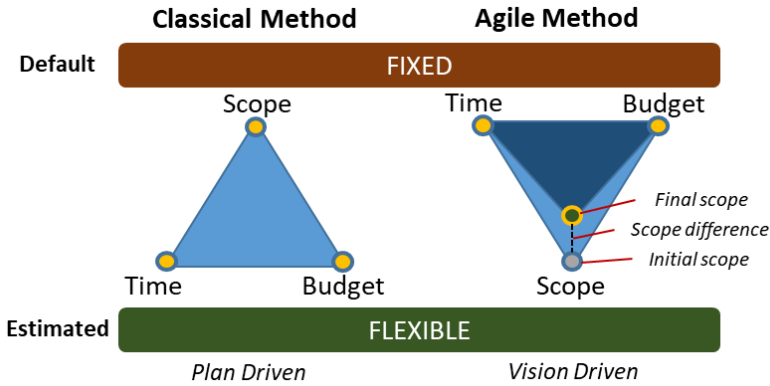Figure 3 presents main the differences between classical Waterfall approach and Agile methodology [10].

Figure 3. Differences between classical Waterfall approach and Agile methodology.

2.3. Agile Project Management Methodology

The basic dependence in Agile Project Management Methodology can be described by the following interaction function [10]:

$$IFR_t \rightarrow (FxT_t, FxB_t) \rightarrow \text{Most important } IFR \text{ and } t \text{ is real moment of time} \qquad (1)$$

where: t – real moment of time;
IFR_t – infrastructure flexible requirements at time t;
FxT_t – flexible time;
FxB_t – flexible budget.

The matrix containing the set of *IFRs* is created as:

$$\text{Matrix of IFRs}(t) \text{ is } \begin{pmatrix} ifr_{1,1} & \cdots & ifr_{1,n} \\ \vdots & \ddots & \vdots \\ ifr_{m,1} & \cdots & ifr_{m,n} \end{pmatrix} \tag{2}$$

where:

n – type of transport (railway, water, road, air, etc.);

m – type of infrastructure (track, pathway, bridge, etc.);

irf – flexible infrastructure requirements by type of transport and infrastructure;

IFR − infrastructure flexible requirement.

In more detail, the essence of Agile Project Management Methodology is presented in [4, 10]. Here, the transport infrastructure flexible requirements represent study interest.

3. Artificial Intelligence in Agile Transport Project Management

It is necessary to note that artificial intelligence [12] has been widely and successfully used in recent years in the management of various projects in different social and economic areas (such as healthcare, information technology, construction, finance, energy, robotics, defense, pharmacology, etc.) [6, 7, 8, 13, 14, 15, 16].

The application of artificial intelligence in transport project management is a complex and multi-parameter task requiring many data on traffic, environment, transport events over time, etc. These data and information are accumulated, processed and analyzed and then form the basis for improving the work of artificial intelligence.

The issues discussed in this article are a special case related to the design and construction of transport infrastructure but this will in any case be an important element of the common task and the challenges to its implementation. In fact, in transport project management, artificial intelligence is increasingly being used, but still the most challenging challenge for the technologies used is the collection of data, their analysis and classification to make the process of learning alone more effective [13].

Most of the transport projects are in the field of transport infrastructure construction.

The artificial intelligence application in the project management of transport infrastructure construction are mostly related to documentary analysis, remote analysis, forecasting, subcontractor analysis, etc. In these cases, the architecture of the project shows the overall picture of the relationships between the team, tasks, and stages of the project. The artificial intelligence can be successfully used to account for this interaction and improve overall project management.

The rapid development of artificial intelligence technologies implies a recent improvement in transport infrastructure project management.

The sample data shown in Table 1 can be collected, analyzed and made available for subsequent implementation and processing in a decision-making system based on artificial intelligence (AI).

This approach can be used in the agile management of transport projects related to the design of information systems for road infrastructure monitoring and traffic management [17, 18,19].

Table 1. Infrastructure Transport Flexible Requirements (ITFRs)

№	Transport, n	Project, m	Infrastructure, m	Flexible Time, FxT	Flexible Budget, FxB
1	Road	1	road $_{(1, 1)}$	FxT $_{(1, 1)}$	FxB $_{(1, 1)}$
		2	highway $_{(1, 2)}$	FxT $_{(1, 2)}$	FxB $_{(1, 2)}$
		3	bridge $_{(1, 3)}$	FxT $_{(1, 3)}$	FxB $_{(1, 3)}$
2	Rail	1	railway $_{(2, 1)}$	FxT $_{(2, 1)}$	FxB $_{(2, 1)}$
		2	station $_{(2, 2)}$	FxT $_{(2, 2)}$	FxB $_{(2, 2)}$
3	Water	1	port $_{(3, 1)}$	FxT $_{(3, 1)}$	FxB $_{(3, 1)}$
		2	port $_{(3,2)}$	FxT $_{(3, 2)}$	FxB $_{(3, 2)}$
4	Air	1	airport $_{(4, 1)}$	FxT $_{(4, 1)}$	FxB $_{(4, 1)}$
5	Pipe	1	pipeline $_{(5, 1)}$	FxT $_{(5, 1)}$	FxB $_{(5, 1)}$

The idea is to create large data sets related to transport, logistics operations, vehicles, types of cargo, cargo volume, speed of freight flows, carriers, routes, infrastructure, workload by hours, days and seasons to be used by artificial intelligence. The data collected is of different types – text, numbers, photos, video, voice, etc. It has been found that the most studied data are those related to transport accidents to improve safety [14]. In these cases, with the help of tools and techniques for analyzing text data and images, artificial intelligence can detect problems that were previously hidden.

4. Conclusion

The presented Agile methodology for transport project management is a new concept for examining and solving project problems, namely "better a quick and effective solution than a very accurate and precise, but timeless". The main advantage of Agile methodology is that it gives the opportunity for improving the planning, management and implementation of transport infrastructure projects, taking into account the importance and characteristics of each one of them.

It is necessary to point out that agile management of transport projects with artificial intelligence application achieves higher efficiency [20, 21].

The future of AI applications in Agile Transport Project Management has a great potential for improving efficiency, safety and sustainability in transportation systems. Some of the potential research trends and developments will include:

- Intelligent traffic management since AI can analyze real-time traffic data from various sources such as sensors, cameras, and connected vehicles to optimize the traffic flow. AI algorithms can dynamically adjust traffic signals, reroute vehicles, and manage traffic, which will lead to reduced travel times and improved traffic efficiency.
- Intelligent route planning, since AI algorithms can analyze historical and real-time data on traffic patterns, weather conditions, events to provide optimized route planning.

- Real-time incident management since AI can analyze real-time data from various sources, such as social media and cameras to detect and respond to transportation incidents. AI algorithms can identify incidents, assess their severity and suggest traffic modes to minimize disruptions and assist in incident management.

References

[1]   U.S. Department of Transportation. The Transportation Planning Process Key Issues A Briefing Book for Transportation Decision-makers, Officials, and Staff. FHWA-HEP-07-039, 2007.

[2]   Malgorzata L. Modular modelling in the analysis of transport infrastructure development plans. 2004; https://www.researchgate.net/publication/235901114_Modular_modelling_in_the_analysis_of_transport_infrastructure_development_plans/stats, 2004.

[3]   Oughton EJ, Usher W, Tyler P, Hall JW. Infrastructure as a complex adaptive system. Complexity 2018 Article ID 3427826, 11 pages.

[4]   Petrova I. Models for Staged Development of Transport Infrastructure. PhD Thesis 2022, # Documents - Dissertant-eng. Irena Velinova Petrova - All Documents (sharepoint.com)

[5]   PMI (Project Management Institute), A Guide to the Project Management Body of Knowledge (PMBOK Guide) and The Standard for Project Management, PMI Seventh Edition, July 2021.

[6]   Dam HK, Tran T, Grundy J, Ghose A, Kamei Y, Towards effective AI-powered agile project management. In: Proceedings of the 41st International Conference on Software Engineering: New Ideas and Emerging Results (ICSE-NIER); May 2019, IEEE/ACM, pp. 41-44.

[7]   Taboada I, Daneshpajouh A, Toledo N, de Vass T, Artificial intelligence enabled project management: A Systematic Literature Review. Applied Sciences 2023; 13(8): article no. 5014.

[8]   Bento S, Pereira L, Gonçalves R, Dias Á, Costa RLD, Artificial intelligence in project management: systematic literature review. Int'Journal of Technology Intelligence and Planning, 2022; 13(2): 143-163.

[9]   Antov A. Multi-Criteria Analysis for Transport Infrastructure Projects, (pdf), Sofia, 2018, http://www.infrarch.com/101/?nav=1.

[10]   Dimitrov D, Petrova I. Strategic Planning and Development of Transport Infrastructures Based on Agile Methodology. Proceedings of the 11th International Scientific Conference on Aeronautics, Automotive and Railway Engineering and Technologies (BulTrans-2019); 2019.

[11]   Beedle M. et al. Manifesto for Agile Software Development, http://agilemanifesto.org/

[12]   IBM. What is artificial intelligence?; 2023 https://www.ibm.com/topics/artificial-intelligence

[13]   Holzmann V, Lechiara M. Artificial Intelligence in Construction Projects: An Explorative Study of Professionals Expectation. European Journal of Business Management and Research 2022;7(3):151-162.

[14]   Dong K, Romanov I, McLellan C, Esen A. Recent text-based research and applications in railways: A critical review and future trends. Eng. Applications of Artificial Intelligence 2022;116, article no. 105435.

[15]   Ong S, Uddin S, Data science and artificial intelligence in project management: the past, present and future. Journal of Modern Project Management 2020; 7(4):1–8.

[16]   Haefner N, Wincent J, Parida V, Gassmann O, Artificial intelligence and innovation management: a review, framework, and research agenda. Technological Forecasting & Social Change 2021;162:1–10.

[17]   Dimitrov D, Zlateva P, Velev D. A Methodology for Designing an Information System for Road Infrastructure Monitoring and Traffic Management in Disasters. Proceedings of the ICESE; 2018 March 11-12, Barcelona, Spain.

[18]   Dobrev D, Dimitrov D. Metro Traffic Management Scheme Based on Wagons Travelling in Autonomous Mode., Proceedings of the 2nd International Conference Transport for Today's Society, University "St. Kliment Ohridski", Faculty of Technical Sciences, Bitola, Republic of Macedonia; 2018.

[19]   Dimitrov D, Zlateva P. Information Model for the Registration of Disasters Affecting the Road Infrastructure. World Science, RS Global 2018 Jan;1(29).

[20]   Tubman A. The use of artificial intelligence in international decision – making processes in project management. SSRN Electronic Journal 2022, article no. 4121200.

[21]   Davahli M. The Last State of Artificial Intelligence in Project management. 2020, CC BY-SA 4.0.