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MCDM approach to investigate the effectiveness of SCRUM events in minimizing risk factors in project management

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A B S T R A C T

Traditional project management methods have been used for many years in the implementation and management of projects. With the publication of the agile manifesto in 2001, the interest in agile methods increased and successful results were obtained in the execution and solution of complex projects with agile approaches. Agile approach consists of different structures that can be named as framework or method. Among these agile methods, which are selected and applied according to the suitability and purpose of the project, the most frequently preferred one is SCRUM. In this study, SCRUM, an agile project management technique that has been used frequently in recent years in order to develop a flexible project management process, has been examined, and the effectiveness of the events of the SCRUM technique in minimizing the risks that arise in project management has been evaluated. Determining the effectiveness of these SCRUM events, which each agile project team implements in turn, is very important for the correct and effective allocation of resources. For this purpose, a multi-criteria decision-making model has been proposed to evaluate the effectiveness of 4 SCRUM events within the scope of this study. While the importance weights of the 24 project management risk factors proposed in the solution phase of the created model were determined by the SWARA method, the SCRUM events were evaluated with the WASPAS, COPRAS and EDAS methods and the solution values found by three different methods were compared.

1. Introduction

In an increasingly competitive environment, the success of the projects carried out by the organizations is of great importance for the survival of the enterprises. For successful project management, the possibility of the emergence of risks should be considered and possible risks should be defined within the project. Project management risk factors that occur for more than one reason can have multiple consequences at the same time. The agile approach is very effective in maintaining the project management more effectively and flexibly, obtaining efficient results, meeting customer needs fully and on time, and most importantly, minimizing all kinds of risks that may be encountered (Marnada et al., 2022; Loiro et al., 2019).

In this study, the risk factors in project management are tried to be determined and the effectiveness of SCRUM events are evaluated to minimize these risk factors. The first objective of the study is to determine and group the most important risk factors in project management. Second, is to examine the effectiveness of SCRUM events for eliminating or minimizing these risk factors. Third and the last one is in all these processes proposing a multi-criteria decision making (MCDM) model and using different solution techniques for obtaining the results of this model. The main objective of this study is to be the first study that is with its model, issue, and solution techniques in literature.

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To achieve these objectives, an MCDM model was proposed with 24 risk factors and 4 alternative SCRUM events. While, the solution of the problem SWARA/Step-wise Weight Assessment Ratio Analysis method was used for determining the importance weights of risk factors, WASPAS/Weighted Aggregated Sum Product Assessment, COPRAS/Complex Proportional Assessment and EDAS/Evaluation based on Distance from Average Solution methods were conducted for finding the most effective SCRUM event in minimizing project management risk factors, respectively.

This paper is divided into five sections. Section 2 is a literature review about agile project management and SCRUM. Section 3 is about the significant concepts, the proposed model with its criteria and alternatives. In Section 4, proposed solution methodology is introduced, and the solution phase is conducted. Finally, the conclusion and future research suggestion's part is in Section 5 at the end of this paper.

2. Literature review

The role of project management within companies is increasing more and more in the face of increasing needs (Nakatsu & Iacovou, 2009). Classical project management methods, on the other hand, are not sufficient in the face of increasing needs. In line with rapidly changing needs and demands, project management is also dynamically developed and fed with new methods. Agile management, which focuses on achieving the highest business value in the shortest time, is one of these new methods. This methodology, which is most used by software development in information technology departments of companies, is also used by other departments of companies (Marnada et al., 2022). Agile management does not focus on the whole, unlike traditional views, but focuses on the parts, thus reducing the risks that can be caused by focusing on the whole (Lalmi et al., 2022). While doing all these, it does not keep the customer out of the process. In this method, where the interaction between individuals are more important than the tools and processes used is more important, also the prototype product is more valuable than the documentation (Gemino et al., 2020). The method, which develops projects gradually with iterations, aims to produce high quality outputs in very short cycles. An important advantage of the agile methodology is that it reduces the cost of the project by eliminating costly changes. In addition, the adaptation to the method is fast, the motivation of the team members is high due to short cycles, the openness to change and flexibility are at a high level (Petersen & Wohlin, 2009). In this method, it is very important that the requests received or the works that need to be completed within the project are prioritized. Overwork due to constantly changing needs and target pressure on the team are the disadvantages of the method. Today, agile software development methods such as Future Driven Development, Extreme Programming, Agile Unified Process, SCRUM, Dynamic System Development Methodology and TestDriven Development are used (Patanakul & Rufo-McCarron, 2018; Vallon et al., 2018). Although there are studies on agile project management in the literature, there is not any study that aims to minimize risk factors with agile frameworks in MCDM concept (Dhir et al., 2018). Only one paper investigated success and failure factors' impacts using agile software development methodology. Except this, Shrivastava and Rathod (2017), Galli (2018), Buganova and Simickova (2019), Tavares et al. (2019) and Mamaghani and Medini (2021) proposed a risk management framework for agile projects.

2.1 SCRUM

Developed by Jeff Sutjerland and Ken Schawaber in the mid-90s, Scrum is the most well-known and widely used agile methodology. While the method is used as an agile software development methodology especially in the software industry, it is also used as a project management approach to manage the product development process (Borandağ & Yücalar, 2020). SCRUM is an agile process framework. That is, it is not a product development technique or process; It is a framework in which various processes and techniques can be used. The SCRUM framework encompasses SCRUM teams and their associated roles, activities, artifacts, and rules. Each component in the framework serves a specific purpose, this is imperative for the success of SCRUM (Garcia et al., 2022; Hron & Obwegeser, 2022).

The SCRUM methodology is designed to maintain a highly flexible development process. SCRUM makes it possible to plan product output and manage variables as the project progresses. This allows organizations to change the project and its deliverables at any time, resulting in the most appropriate product output in the shortest possible time. SCRUM helps users plan and oversee a project throughout all development phases. In the method, instead of creating tasks and comprehensive project plans, the entire time plan is divided into two-week phases called "sprint". At the start of each sprint, priority jobs are determined by the product owner. This planned work list is completed at the end of two weeks and transferred to the production environment and the new version of the application is presented to the product owner for evaluation. This process continues until the product reaches sufficient maturity. As the method provides the opportunity to review business requirements and change priorities during two-week development periods, the highest value product possible can be developed with this method. At the same time, the quality and speed of production increases with the transparency and daily information sharing provided by teamwork (Endres et al., 2022; Cano et al., 2021).

A product owner, development team and a SCRUM master consist of the SCRUM team (Hron & Obwegeser, 2022). SCRUM teams are self-directed and cross-functional. All teams are customer-based. Self-directed teams decide for themselves how best to accomplish their work, rather than taking orders from someone outside the team. Cross-functional teams have all the competencies to get the job done without being dependent on people outside the team. The SCRUM team has been designed with the goal of maximizing flexibility, creativity and productivity.

3. Model proposal for investigation of the effectiveness of SCRUM events

In this section, schematic view of proposed model is introduced with its criteria and alternatives.

3.1 Creating research criteria

When the literature is examined, there are many risk factors recommended, accepted and widely used by researchers within the scope of project management. The main of these factors constitute the research criteria of this study, and they are given in Table 1 together with the literature sources from which they were obtained. Since all these research criteria are risk factors, it is aimed to eliminate or minimize them. Therefore, all the criteria proposed in this study are cost-based.

Table 1
Project management risk factors (research criteria)

	Risk factor	Reference		Risk factor	References
R_1	Lack of communication	(Nakatsu & Iacovou, 2009; Menezes et al. 2019; Mamoghli et al, 2018; Elzamly et al., 2016)	R_2	Lack of role and responsibility	(Kumar & Yaday, 2015)
R_3	Lack of information sharing		R_4	Lack of agile training	(Elzamly et al., 2016)
R_5	Lack of motivational strategies	(Nakatsu & Iacovou, 200; Menezes et al. 2019; Kumar & Yaday, 2015)	R_6	Weak organizational infrastructure	(Nakatsu & Iacovou, 2009; Menezes et al. 2019)
R_7	Wrong coordination		R_8	Resistance to change	(Elzamly et al., 2016)
R_9	Lack of mutual trust		R_{10}	Large team size	(Kumar & Yaday, 2015; Jiang & Klein, 2000)
R_{11}	Undisclosed responsibilities		R_{12}	Lack of software capability	(Elzamly et al., 2016; Houston et al., 2001)
R_{13}	Lack of customer engagement	(Nakatsu & Iacovou, 2009; Menezes et al. 2019; Mamoghli et al, 2018; Elzamly et al., 2016; Houston et al., 2001)	R_{14}	Lack of scaling tools and standards	Menezes et al. 2019; Elzamly et al., 2016; Houston et al., 2001)
R_{15}	Project size and complexity	(Kumar & Yaday, 2015; Houston et al., 2001; Jiang & Klein, 2000)	R_{16}	Time differences	(Elzamly et al., 2016; Cheng et al., 2006)
R_{17}	Inefficient/Incorrect data entry	(Elzamly et al., 2016; Houston et al., 2001)	R_{18}	Data security concerns	(Elzamly et al., 2016)
R_{19}	Unclear legal liability		R_{20}	Insufficient project experience	(Menezes et al. 2019; Kumar & Yaday, 2015; Houston et al., 2001)
R_{21}	Budget constraints	(Nakatsu & Iacovou, 2009; Menezes et al. 2019; Elzamly et al., 2016; Cheng et al., 2006; Houston et al., 2001)	R_{22}	Inappropriate communication technologies	(Nakatsu & Iacovou, 2009; Menezes et al. 2019; Mamoghli et al, 2018; Elzamly et al., 2016)
R_{23}	Excessive workload		R_{24}	Inexperienced staff	(Menezes et al. 2019)

3.2 Creating research alternatives

SCRUM events are used to minimize the need for meetings that are not defined in SCRUM and to ensure regularity. All events are time limited, with each event having a maximum duration. Events come to an end when their goals are achieved, so that an appropriate amount of time is spent in the process, avoiding wastage. Specially designed to enable transparency and observation, which are of great importance in the agile approach, these events are an opportunity for observation and adaptation (scrumguides.org)

In this study, which was carried out to measure the effectiveness of SCRUM events for minimizing risk factors in project management, 4 main SCRUM events were accepted as research alternatives and are explained below (Endres et al., 2022; Cano et al., 2021):

- E_1 Sprint planning: The work to be done is planned with this meeting. This plan is created with the collaboration of the entire SCRUM team.
- E_2 Daily scrum: It consists of 15-minute meetings held every day. Daily scrums make forecasts for the next day as well as planning. In these meetings, which aim to reduce complexity, each member answers questions about what has been accomplished since the last meeting and what will be done at the next meeting.
- E_3 Sprint review: The Scrum team and stakeholders discuss the work done in the sprint at this meeting. Based on this conversation and changes to the product backlog during the sprint, participants collaborate to identify what can be done

to maximize value. The purpose of presenting the product at this event, which is a due diligence meeting, is to get feedback and increase collaboration.

- E_4 Sprint retrospective: It is an opportunity for the SCRUM team to self-observe and create a plan for improvements to be made in the next sprint. In this event, the aim is to observe how the last sprint goes in terms of people, relationships, process and tools, identify and list the good points and possible improvement areas, and create a plan that will improve the way the SCRUM team does business.

Proposed research model's hierarchical schematic view is shown in Fig. 1.

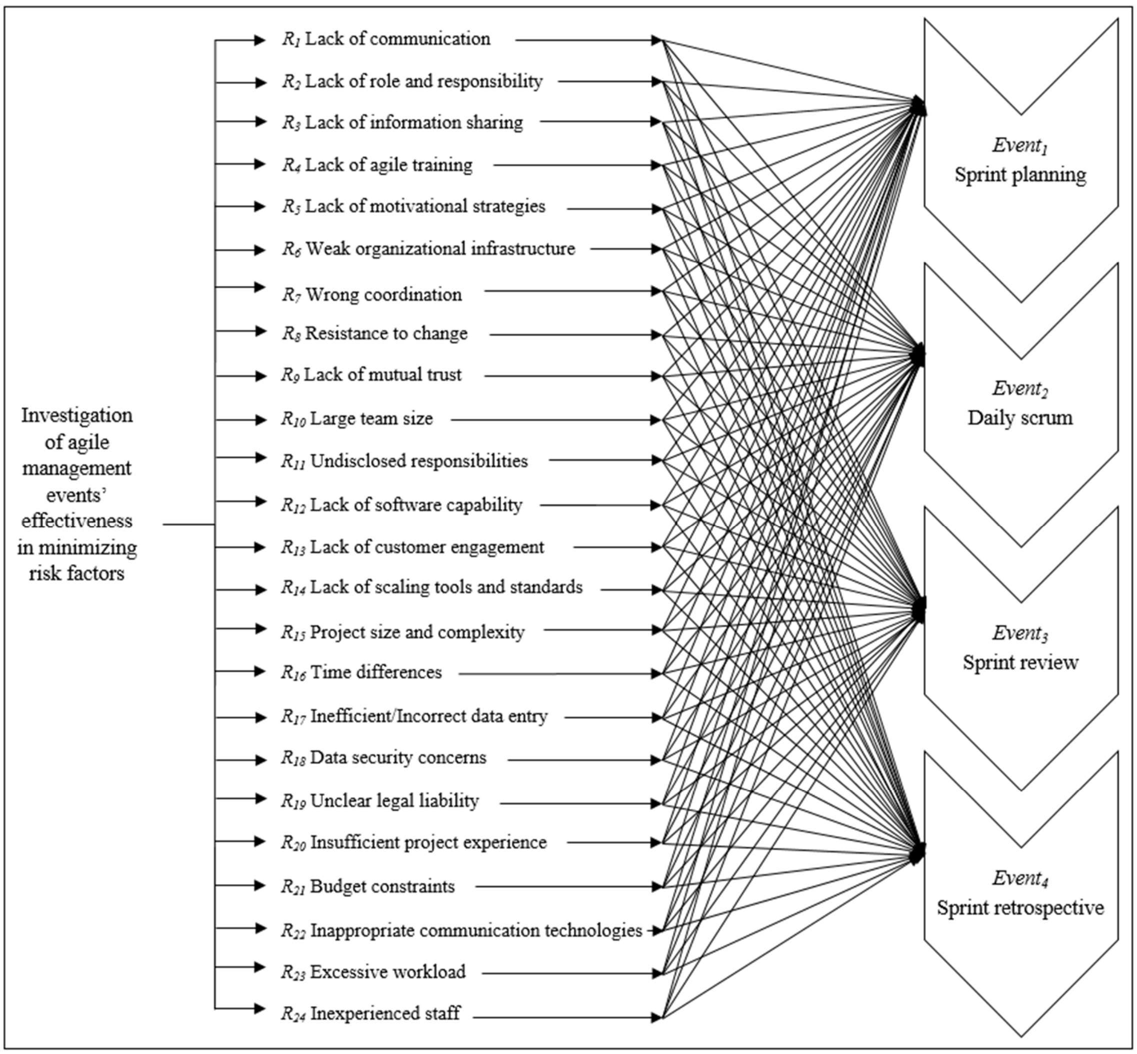

Fig. 1 The research model's schematic view

4. Application

A two-stage methodology was proposed for the solution of the problem.
In the first stage of the solution methodology, the importance weights of the 24 risk factors that are contained in the MCDM model were calculated with the SWARA method. Then, four SCRUM events were evaluated with WASPAS, COPRAS, EDAS methods for eliminating or minimizing these project management risk factors, respectively. The obtained results by three different MCDM techniques were compared.

The proposed two-stage MCDM solution methodology is shown in Fig. 2.

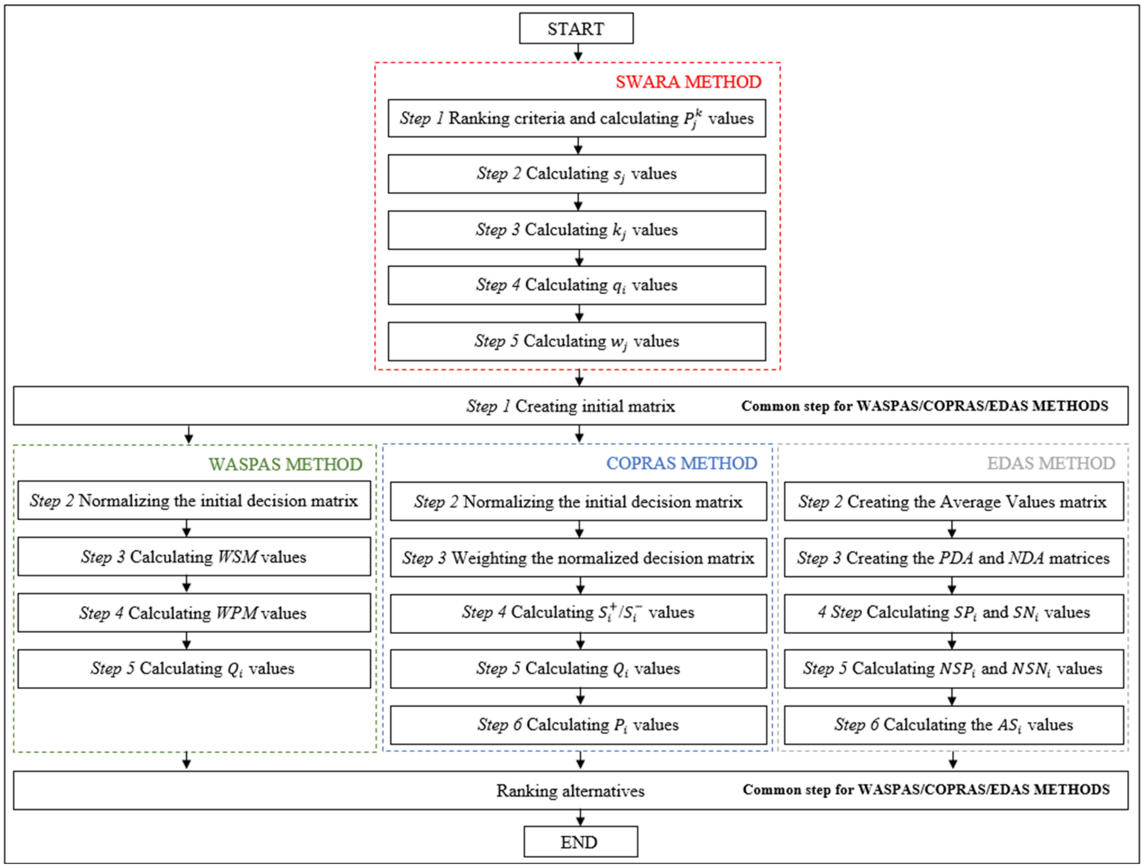

Fig. 2. The proposed two-stage MCDM solution methodology

Throughout this study for the application part of the problem, the educational status, professional experience, agile management title and experience of the 4 experts who were asked to evaluate the criteria and alternatives are shown in Table 2.

Table 2
Information of Agile Coaches

AC	Education	Experience (year)	Agile title	Experience/agile (year)
AC_1	Bachelor	25	Agile coach	2
AC_2	Master	20	Agile coach & Agile office leader	5
AC_3	Bachelor	25	Agile coach & Freelance consultant coach	5
AC_4	Bachelor	15	Agile office leader	4

4.1 The implementation of SWARA method

The SWARA method used to calculate the importance weights of the criteria determined in order to rank the alternatives in MCDM problems was developed by Keršuliene et al. in 2010 (Yazdi et al., 2022). The method has some advantages such as applying easily and having fewer implementation steps compared to other criteria weight calculation methods used in the literature. The SWARA method is based on the opinions of the experts in calculating the importance weight of the criteria and is based on the ranking of the criteria from the most important to the least important by the experts. The implementation steps of the method are as follows (Yazdi et al., 2022; Yücenur et al., 2020):

Step 1 Ranking criteria and calculating P_j^k values: Experts rank the criteria, giving a value of *1.00* to the criterion of the most important to them. Comparative importance scores of other criteria are determined by comparison with the most important criterion and varied from *1.00* to *0.00*. After all ranking values are determined by experts, the average importance score (P_j^k) is calculated for each criterion. Here, *j* represents the number of criteria and *k* the number of expert.

Step 2 Calculating s_j values: Relative importance scores are calculated by taking the P_j^k differences of the criteria, respectively.

Step 3 Calculating k_j values: The k_j coefficient to be used in the calculation of importance vector is calculated with the help of Eq. 1.

$$k_j = \begin{Bmatrix} 1, & j = 1 \\ s_j + 1, & j > 1 \end{Bmatrix} \tag{1}$$

Step 4 Calculating q_i values: The importance vectors to be used in the calculation of criterion weights are calculated with the help of Eq. 2.

$$q_i = \begin{Bmatrix} 1, & j = 1 \\ \frac{q_{j-1}}{k_j} & j > 1 \end{Bmatrix} \tag{2}$$

Step 5 Calculating w_j values: The importance weights of the criteria are calculated with the help of Eq. 3.

In this paper, 24 risk factors were determined as decision criteria and ranked by 4 agile coaches who are service sector employees and experienced with agile teams for 5-10 years. The implementation results of SWARA method are shown in Table 3.

Table 3
The results of SWARA method

	Agile coaches				P_j^k		P_j^k	s_j	k_j	q_i	w_j
	AC_1	AC_2	AC_3	AC_4							
R_1	1.00	0.95	0.99	0.79	0.9329	R_1	0.9329	-	1.0000	1.0000	0.0577
R_2	0.69	0.93	0.79	1.00	0.8525	R_{13}	0.8538	0.0792	1.0792	0.9266	0.0535
R_3	0.74	0.94	0.97	0.75	0.8500	R_2	0.8525	0.0012	1.0013	0.9255	0.0534
R_4	0.40	1.00	0.75	0.92	0.7667	R_3	0.8500	0.0025	1.0025	0.9232	0.0533
R_5	0.60	0.89	0.80	0.29	0.6454	R_8	0.7992	0.0508	1.0508	0.8785	0.0507
R_6	0.75	0.88	0.69	0.71	0.7571	R_9	0.7863	0.0129	1.0129	0.8673	0.0500
R_7	0.44	0.87	0.70	0.50	0.6275	R_4	0.7667	0.0196	1.0196	0.8507	0.0491
R_8	0.90	0.90	0.98	0.42	0.7992	R_{10}	0.7658	0.0008	1.0008	0.8499	0.0490
R_9	0.97	0.80	1.00	0.38	0.7863	R_6	0.7571	0.0088	1.0088	0.8426	0.0486
R_{10}	0.80	0.79	0.89	0.58	0.7658	R_{11}	0.7458	0.0113	1.0113	0.8332	0.0481
R_{11}	0.68	0.59	0.88	0.83	0.7458	R_5	0.6454	0.1004	1.1004	0.7572	0.0437
R_{12}	0.25	0.60	0.74	0.25	0.4600	R_7	0.6275	0.0179	1.0179	0.7438	0.0429
R_{13}	0.99	0.65	0.90	0.88	0.8538	R_{15}	0.5042	0.1233	1.1233	0.6622	0.0382
R_{14}	0.50	0.48	0.11	0.33	0.3558	R_{23}	0.5038	0.0004	1.0004	0.6619	0.0382
R_{15}	0.37	0.68	0.30	0.67	0.5042	R_{12}	0.4600	0.0438	1.0438	0.6342	0.0366
R_{16}	0.65	0.49	0.01	0.04	0.2979	R_{24}	0.4096	0.0504	1.0504	0.6037	0.0348
R_{17}	0.20	0.46	0.60	0.01	0.3175	R_{21}	0.3667	0.0429	1.0429	0.5789	0.0334
R_{18}	0.15	0.45	0.33	0.08	0.2533	R_{14}	0.3558	0.0108	1.0108	0.5727	0.0330
R_{19}	0.12	0.44	0.31	0.13	0.2488	R_{17}	0.3175	0.0383	1.0383	0.5515	0.0318
R_{20}	0.18	0.47	0.05	0.54	0.3104	R_{22}	0.3146	0.0029	1.0029	0.5499	0.0317
R_{21}	0.30	0.50	0.50	0.17	0.3667	R_{20}	0.3104	0.0042	1.0042	0.5476	0.0316
R_{22}	0.45	0.58	0.02	0.21	0.3146	R_{16}	0.2979	0.0125	1.0125	0.5409	0.0312
R_{23}	0.59	0.70	0.10	0.63	0.5038	R_{18}	0.2533	0.0446	1.0446	0.5178	0.0299
R_{24}	0.17	0.69	0.32	0.46	0.4096	R_{19}	0.2488	0.0046	1.0046	0.5154	0.0297

According to Table 3, lack of communication (R_1) is the most important risk factor for project management with 0.0577 importance weight value. Lack of customer engagement (R_{13}) and lack of role and responsibility (R_2) are the other important risks with 0.0535 and 0.0534 values. On the other hand, data security concerns (R_{18}) and unclear legal liability (R_{19}) are the least important risks for the project management process.

4.2 The implementation of WASPAS/COPRAS/EDAS method

After the importance weights of the risk factors were obtained with the SWARA method, it was time to rank SCRUM events in eliminating these risk factors. In Table 4, an initial matrix was created by agile coaches by evaluating 4 SCRUM events for 24 risk factors. This created matrix will be solved by WASPAS, COPRAS and EDAS methods, respectively.

Table 4
Initial matrix of the evaluations

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
w_j	0.0577	0.0534	0.0533	0.0491	0.0437	0.0486	0.0429	0.0507
E_1	85.00	87.50	85.00	38.75	38.75	66.25	87.50	51.25
E_2	95.00	62.50	100.00	30.00	40.00	37.50	82.50	58.75
E_3	67.50	41.25	67.50	18.75	36.25	45.00	60.00	46.25
E_4	82.50	70.00	61.25	75.00	85.00	87.50	50.00	90.00

	R_9	R_{10}	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	R_{16}
w_j	0.0500	0.0490	0.0481	0.0366	0.0535	0.0330	0.0382	0.0312
E_1	62.50	50.00	90.00	68.75	33.75	56.25	87.50	71.25
E_2	80.00	46.25	77.50	70.00	28.75	51.25	61.25	90.00
E_3	53.75	43.75	52.50	28.75	100.00	23.75	70.00	22.50
E_4	100.00	81.25	88.75	91.25	66.25	57.50	82.50	72.50

	R_{17}	R_{18}	R_{19}	R_{20}	R_{21}	R_{22}	R_{23}	R_{24}
w_j	0.0318	0.0299	0.0297	0.0316	0.0334	0.0317	0.0382	0.0348
E_1	56.25	62.50	62.50	72.50	75.00	62.50	95.00	72.50
E_2	58.75	70.00	65.00	61.25	40.00	75.00	73.75	66.25
E_3	28.75	28.75	33.75	60.00	62.50	41.25	60.00	38.75
E_4	42.50	48.75	38.75	36.25	32.50	76.25	77.50	70.00

4.2.1 WASPAS method

The WASPAS method was proposed in 2012 by Zavadskas et al. The important advantage of this method, which combines the results of two different models, the "Weighted Sum Model" and the "Weighted Product Model", does not require a sensitivity test. The combined optimal values are calculated with the method and the alternatives are ranked (Kandi et al., 2022). The implementation steps of the method are as follows (Behera et al., 2022):

Step 1 Creating initial matrix: An initial decision matrix that shows the performance of the alternatives according to the criteria is created (Table 4).

Step 2 Normalizing the initial decision matrix: Decision matrix is normalized according to whether the criteria are cost or benefit-based. In this study, since all risk factors are cost-based and tried to be minimized, the normalization process is performed with the help of Eq. (3).

$$x_{ij}^* = \frac{min_i x_{ij}}{x_{ij}} \quad (3)$$

Step 3 Calculating WSM values: The performance of the alternatives according to the Weighted Sum Model (*WSM*) is calculated with the help of Eq. (4). The w_j values used here were obtained by the SWARA method.

$$Q_i^{(1)} = \sum_{j=1}^{n} x_{ij}^* \, w_j \quad (4)$$

Step 4 Calculating WPM values: The performance of the alternatives according to the Weighted Product Model (*WPM*) is calculated with the help of Eq. (5). The w_j values used here were obtained by the SWARA method.

$$Q_i^{(2)} = \prod_{j=1}^{n} \left(x_{ij}^*\right)^{w_j} \quad (5)$$

Step 5 Calculating Q_i values: The final performance of the alternatives is obtained by summing their relative performances with the help of Eq. (6).

$$Q_i = 0.5\, Q_i^{(1)} + 0.5\, Q_i^{(2)} \quad (6)$$

Step 6 Ranking alternatives: The alternatives are ranked by Q_i values. The alternative with the highest Q_i values is the best one.

The implementation results of WASPAS method are shown in Table 5.

Table 5
The results of WASPAS method

	$Q_i^{(1)}$	$Q_i^{(2)}$	Q_i ($\lambda = 0.5$)	Ranking
E_1 Sprint planning	0.6371	0.5214	*0.5793*	3
E_2 Daily scrum	0.6940	0.5908	0.6424	2
E_3 Sprint review	0.9085	0.8579	0.8832	1
E_4 Sprint retrospective	0.6168	0.4775	0.5472	4

4.2.2 COPRAS method

The COPRAS method, which was introduced by Zavadskas and Kaklauskas in 1996, is used in the ranking and evaluation of alternatives, taking into account the benefit and cost characteristics of the criteria. The method that compares the alternatives with each other and can express the superiority of each other as a percentage has some advantages such as ease of the process steps and does not need any computer program for calculations (Patil et al., 2022). The implementation steps of the method are as follows (Yücenur et al., 2020):

Step 1 Creating initial matrix: An initial decision matrix that shows the performance of the alternatives according to the criteria is created (Table 4).

Step 2 Normalizing the initial decision matrix: The normalized decision matrix is calculated with the help of Eq. (7).

$$x_{ij}^* = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad (7)$$

Step 3 Weighting the normalized decision matrix: The elements of the normalized matrix are calculated with the help of Eq. (8) by multiplying the importance weights. The w_j values used here were obtained by the SWARA method.

$$n_{ij} = x_{ij}^* w_j \quad (8)$$

Step 4 Calculating S_i^+/S_i^- values: While calculating the S_i^+ value, the benefit-based criteria values in the weighted normalized decision matrix are summed, while the cost-based criteria values in the same matrix are summed for S_i^-. In this study, since all risk factors are cost-based criteria that are tried to be minimized, S_i^+ values are zero for all alternatives, while S_i^- values are calculated.

Step 5 Calculating Q_i values: The relative importance values are obtained with the help of Eq. (9).

$$Q_i = S_i^+ + \frac{\sum_{i=1}^{m} S_i^-}{S_i^- \sum_{i=1}^{m}\left(\frac{1}{S_i^-}\right)} \tag{9}$$

Step 6 Calculating P_i values: The performance index values for all alternatives are obtained with the help of Eq. (10).

$$P_i = \left(\frac{Q_i}{Q_{max}}\right) 100 \tag{10}$$

Step 7 Ranking alternatives: The alternatives are ranked by P_i values. The alternative with the highest P_i values is the best one.

The implementation results of COPRAS method are shown in Table 6.

Table 6
The results of COPRAS method

	S_i^+	S_i^-	Q_i	P_i	Ranking
E_1 Sprint planning	0.000	0.2673	0.2286	72.4575	3
E_2 Daily scrum	0.000	0.2490	0.2454	77.7761	2
E_3 Sprint review	0.000	0.1937	0.3155	100.0000	1
E_4 Sprint retrospective	0.000	0.2900	0.2106	66.7646	4

4.2.3 EDAS method

The EDAS method, which was introduced by Ghorabaee et al. in 2015, is based on determining the mean values for the criteria and taking the positive and negative distances calculated from this mean value as a basis in the evaluation of alternatives. The implementation steps of the method are as follows (Yazdani et al., 2020):

Step 1 Creating initial matrix: An initial decision matrix that shows the performance of the alternatives according to the criteria is created (Table 4).

Step 2 Creating the Average Values matrix: The matrix of average values for the criteria is obtained with the help of Eq. (11).

$$AV_j = \frac{\sum_{i=1}^{n} x_{ij}}{n} \tag{11}$$

Step 3 Creating the PDA and NDA matrices: Eq. (12) and Eq. (13) are used to construct the positive distance matrix (*PDA*) from the mean and the negative distance matrix (*NDA*) from the mean for each criterion, respectively.

$$PDA = \left[PDA_{ij}\right]_{n\times m} \tag{12}$$

$$NDA = \left[NDA_{ij}\right]_{n\times m} \tag{13}$$

The calculation of these values varies depending on whether the criteria are benefit-based or cost-based. In this study, since all criteria are cost-based, matrix calculations are obtained with the help of Eq. (14) and Eq. (15).

$$PDA_{ij} = \frac{max\left(0, \left(AV_j - X_{ij}\right)\right)}{AV_j} \tag{14}$$

$$NDA_{ij} = \frac{max\left(0, \left(X_{ij} - AV_j\right)\right)}{AV_j} \tag{15}$$

4 Step Calculating SP_i and SN_i values: Weighted total positive distances (SP_i) and weighted total negative distances (SN_i) values are calculated with the help of Eq. (16) and Eq. (17). The w_j values used here were obtained by the SWARA method.

$$SP_i = \sum_{j=1}^{m} w_j \times PDA_{ij} \tag{16}$$

$$SN_i = \sum_{j=1}^{m} w_j \times NDA_{ij} \tag{17}$$

Step 5 *Calculating NSP_i and NSN_i values*: For all alternatives normalized weighted total distances are calculated with the help of Eq. (18) and Eq. (19).

$$NSP_i = \frac{SP_i}{max_i(SP_i)} \tag{18}$$

$$NSN_i = 1 - \frac{SN_i}{max_i(SN_i)} \tag{19}$$

Step 6 Calculating the AS_i values: The success scores (AS_i) to be used in performance evaluation for each alternative are obtained with the help of Eq. (20).

$$AS_i = \frac{1}{2} \times (NSP_i + NSN_i) \tag{20}$$

Step 7 Ranking alternatives: The alternatives are ranked by AS_i values. The alternative with the highest AS_i values is the best one.

The implementation results of EDAS method are shown in Table 7.

Table 7
The results of EDAS method

	SP_i	SN_i	NSP_i	NSN_i	AS_i	Ranking
E_1 Sprint planning	0.0557	0.1248	0.2037	0.4334	0.3186	3
E_2 Daily scrum	0.0951	0.0911	0.3480	0.5865	0.4673	2
E_3 Sprint review	0.2732	0.0478	1.0000	0.7830	0.8915	1
E_4 Sprint retrospective	0.0599	0.2202	0.2194	0.0000	0.1097	4

4.3 Application results and comparisons

According to the WASPAS method in Table 5, the sprint review event is the most effective one for minimizing risk factors with 0.8832 final performance rate. This alternative is followed by a daily scrum event with 0.6424 final performance rate. The ranking of SCRUM events' effectiveness for minimizing project management risk factors are sprint review, daily scrum, sprint planning and sprint retrospective, respectively. According to the results of the COPRAS method in Table 6, the sprint review event is the most effective one for minimizing risk factors with 100.00 performance index value. This alternative is followed by a daily scrum event with 77.7761 performance index value. The ranking of SCRUM events' effectiveness for minimizing project management risk factors are sprint review, daily scrum, sprint planning and sprint retrospective, respectively, same as WASPAS method. According to the results of the EDAS method in Table 7, the sprint review event is the most effective one for minimizing risk factors with a 0.8915 success score. This alternative is followed by a daily scrum event with a 0.4673 success score. The ranking of SCRUM events' effectiveness for minimizing project management risk factors are sprint review, daily scrum, sprint planning and sprint retrospective, respectively, same as WASPAS and COPRAS methods. In Fig. 3, the comparison of the results that are obtained by three different MCDM methods is shown. All values that are shown in the graphic are added to the graphic after normalizing in their method.

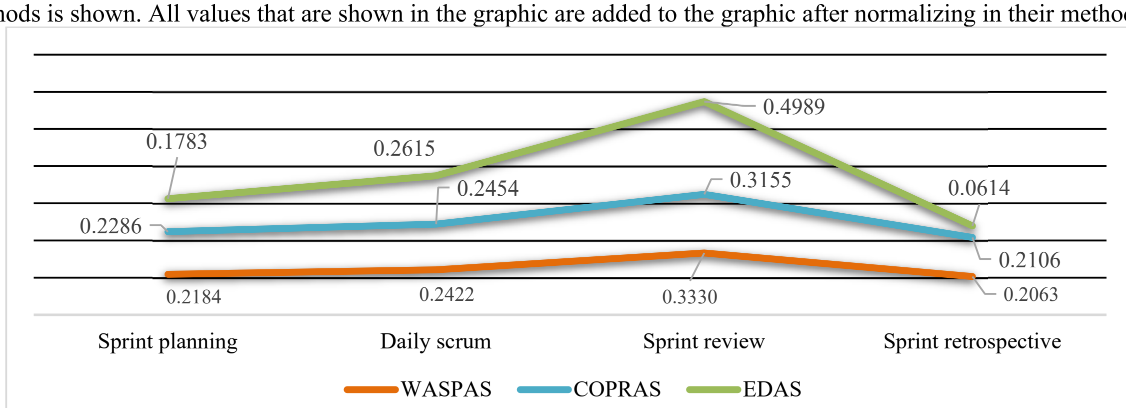

Fig. 3. Comparison of normalized results of WASPAS/COPRAS/EDAS methods

As seen in Fig. 3, although the normalized values are different, the ranking found by all three techniques is the same. According to this result, sprint review is the most effective SCRUM event to eliminate or minimize the risk factors that may be encountered in project management. Agile teams can prevent risk factors by giving more attention and importance to this event.

4. Conclusion and Future research suggestions

Agile project management is a method based on quick and easy response to changing conditions, enabling organizations to work more quickly with smaller teams, offering less waste, more flexibility, adaptability and more customer focus. Successful agile teams within agile project management achieve results faster than traditional teams and produce a higher quality output that better meets user needs at a lower cost. Especially in organizations that become agile by adopting an agile framework such as SCRUM, customer/user satisfaction is quite high.

This study was conducted to evaluate the effectiveness of SCRUM events, which is an agile management framework, in order to eliminate and/or minimize the risk factors to be encountered in project management. For this purpose, a MCDM model was proposed within the scope of the study and this proposed model was solved by using 4 different MCDM methods in 2 stages. The obtained solution values were compared and SCRUM events were ranked according to their effectiveness on risk factors.

Although this study is important in terms of its contribution to the literature, the model and solution methods it proposes applied to a problem in project management for the first time, it also contains a limitation such as the narrowness of the evaluation team. In future studies, development of the evaluation team, revision of the model and/or separate evaluation of SCRUM activities for different product/service projects or evaluation of the activities of different agile approaches with the same risk factors can be carried out.

As a final word, in project management SCRUM should be kept as simple as possible and introduced as a general method that contains the basic requirements for its implementation. Each organization should form its SCRUM to its own needs, as strict rules can result in loss of flexibility and efficiency. Risk factors that may occur in project management should also be reviewed during the review phase of the SCRUM sprint, and improvements should be made to ensure that the outputs are in line with the targeted quality and customer needs. This research was carried out to provide guidance for companies that are starting or planning to start agile transformation. The findings will contribute to both academic and sectoral research in the future.

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