

AUTOMOTIVE PROJECT RISK MANAGEMENT IN AGILE ENVIRONMENTS: INSIGHTS FROM GLOBAL EXPERT OPINIONS USING Q-METHODOLOGY

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Abstract

Automotive industry is a complex environment described by high quality standard requirements, global supply chains and high pressure to comply with latest customer expectations. Therefore risk management is essential for companies operating in this environment. In this study we aimed to understand expert opinion regarding automotive risks. Response has been collected from 119 experts mostly in automotive environment. We used Q-method to analyze dominant opinion groups and additionally requested feedback regarding proposed risk mitigation measures. Key observation is that time-related issues dominates the expert opinion. Based on the the factor analysis we revealed a major (focusing on day-to-day problems) and minor (focusing on organization and structural problems) opinion group. Subgroup analysis based on experience, methodological preference, industry and nationality reveled valuable insights to better understand risk perception. Qualitative part of the survey regarding mitigation measures showed importance of planning, monitoring and communication. The research work contributes to the understanding of risk patterns in agile automotive environment and can provide guidance for practitioners.

Keywords: *risk management, automotive, agile, Q-methodology, project management*

1. Introduction

Automotive historically can be characterized as an industry which developed standards to conform high safety and environment regulations to minimize risk for the end-users (Simonazzi et al., 2020). In the past decades automotive became more and more competitive, where OEMs and supplier fighting for profit margins (suppliers account for approx. 60% of a vehicles value) which means risk management essential (Dehdar et al., 2018).

This study intends to examine and better understand the project specific risks within automotive industry in the growingly complex, agile environment. The topic became more important and urgent due to global disruptions: COVID-19 pandemic for instance showed the vulnerability of supply chains (Goran, 2022). Due to the size of the automotive sector itself we need to highlight the importance in the economy: it employs 13.2 million people in the EUR (Brown et al., n.d.). In Hungary, automotive adds 26% of overall manufacturing volume and gives job to at least 150,000 workers (HIPA Elemzési Osztály, 2024) and Hungary aims to become a leader in EU as a test hub and electromobility infrastructure leader.

The industry faces significant challenges and pressure: growing environmental regulation, new technological development, digitalization [for example the increasing trend of patents related to electromobility shows the forecast of the industry (IEA, 2024; n.d.)]. As a results we need to question if traditional management approaches are still valid (Dehdar et al., 2018).

Globalization added a new dimension to risks, including opportunities and threats. In the 20th century project management generally improved as a result of IT developments with growing importance of dedicated risk management (Ahmed et al., 2007). However these practices has been usually designed for large companies which questions their applicability in agile environments (Askarpour et al., 2024; Elkins et al., 2004).

Our research uses the combination of Q-methodology and questionnaire to understand how automotive experts think about risks. We try to understand which risks dominate and what mitigation practices are common.

2. Literature review

2.1. Risk management fundamentals

Uncertainty is an integral part of every project. This can greatly affect the objective of the project which drives the need to control and monitor the risk events. This means identification, assessment, response and monitoring of such risks (de Oliveira et al., 2017: 31). Risk by definition is an uncertain event which affects project objectives (like time, quality, cost or scope) if occurs, whether it is positive or negative. PMBOK defines a general risk management process: plan risk management, identify risks, qualitative/quantitative risk analysis, plan and implement responses and monitor risks through the project lifetime (Project Management Institute, 2017).

There are several tools to operatively execute risk management: probability-impact matrix, risk register, Monte Carlo simulations, SWOT analysis (Ahmed et al., 2007; Fekete, 2015). We can categorize risks based on multiple criteria: source of the risk (internal or external), affect on (time, quality, cost, scope) or their point of occuring (planning phase, execution phase, etc.). In complex systems, such as automotive supply chains we need a holistic risk approach to reduce the effect of interconnecting risk elements (Thamhain, 2013).

To narrow the scope of the study we need to understand certain elements of project succes and create a database of items which can be part of the quantitative and qualitative analysis. Project success often based on having a proper sponsor, team and environment (Cooke-Davies, 2002). The sponsor defined overall strategy and ensure resources (Turner & Müller, 2005). If team capabilites are missing or dysfunctional it will lead to delays and failures (Boehm, 1991). Cooperation and communication issues are frequent which can lead to major project obstacles (Dinsmore, 2014) or general stakeholder interconnection has a similar affect on project targets (Pinto, 2020).

There are evidences that risk identification an integral part of the process, structured way with matrix, checklists can help to establish risk transparency (Thamhain, 2013) and avoid overlooking some aspects (KENDRICK, 2009). Practical frameworks, like the “six W’s” (who, what, when, where, why, how) are also useful especially in automotive environment where these approaches are common due to traditions of Lean manufacturing (Johansen et al., 2014).

Recent studies highlight that the growing volatility in global markets further reinforces the importance of structured risk management processes across industries, including automotive and other complex manufacturing domains. Contemporary analyses emphasize that traditional probabilistic tools must increasingly be complemented with resilience-focused and data-driven techniques in response to system complexity and uncertainty (Herring et al., 2025). Modern project environments also face heightened exposure to geopolitical tensions, technological disruptions and supply shortages, which require organizations to extend classical PMBOK-aligned frameworks with dynamic sensing, early-warning mechanisms and cross-functional scenario simulations (Herring et al., 2025). This reflects a wider shift from static risk registers toward adaptive, iterative risk cycles capable of responding to fluctuating external conditions.

In line with this shift, recent literature also stresses the importance of integrating digital technologies into risk identification and assessment. Artificial intelligence and advanced analytics have become increasingly relevant, enabling project teams to detect anomalies, forecast probabilistic outcomes, and evaluate interdependencies among risk drivers — capabilities especially valuable in multi-tier industrial ecosystems (Beecham, 2025). Such tools strengthen risk transparency, support decision-making quality and enable more proactive mitigation strategies.

Additionally, new research on supply chain disruptions triggered by global crises — such as pandemics, semiconductor shortages, and geopolitical conflicts — provides evidence that project success is strongly correlated with an organization’s ability to anticipate systemic risks that are beyond the scope of traditional project-level assessments (Eldem et al., 2022). These studies reinforce that risk management should not be confined to project boundaries but embedded within the broader organizational resilience architecture.

2.2. Automotive industry risk characteristics

Automotive has some characteristic which are different from other industries. It has serious safety and environment standards – the major automotive standard is the IATF 16949 (International Automotive Task Force & Verband der Automobilindustrie, 2016). Complex supply chains and rapid technological innovation pressure due to quickly changing customer demands. Furthermore the production output generally high-volume, stocks needs to be on lowest possible levels and reduction of waste is key through the whole supply-chain.

Most frequent risk sources can be classified as demand fluctuation, operational problems, supply chain disruptions and geopolitical changes (Dehdar et al., 2018). Increasing time pressure seems to be present in the whole supply chain due to the decreased new product launch cycles and general market competition, which means a shift towards more agile environment (Cooper & Sommer, 2016).

Projects can be the sources of risks but also action of risk mitigation (Chapman & Ward, 2003). Traditional risk management defines 4 categories to react to risk event: mitigate, avoid, transfer and accept (Project Management Institute, 2019).

Agile philosophy (originating from production environment and widely spread by IT industry) supports main principles like customer first, welcome changes and delivery prototypes as soon as

possible (Highsmith & Fowler, 2001). Automotive industry might leverage to apply agile methods in its processes (Venczel et al., 2024).

The application of agile practices combined with traditional risk management practices can help in projects by enabling adaptive project progression and risk assessment (Askarpour et al., 2024).

Recent industry-focused research reveals that automotive firms are operating in an environment of unprecedented turbulence, requiring more advanced and holistic risk management approaches. The Global Automotive Risk Outlook 2024 indicates that the sector's rapid technological evolution — particularly in electrification, automation, and software integration — has introduced new categories of technical, regulatory and cybersecurity risks, with increased ambiguity regarding liability for software and system failures ('Global Automotive Risk Outlook: Rethinking the Risk Landscape of Automotive Manufacturing', 2024). This aligns with broader findings that modern vehicles' escalating complexity, involving more than 30,000 components per car, fundamentally amplifies the industry's exposure to interconnected failure modes.

Supply chain fragility continues to be one of the most dominant risk sources. Research from Supply Chain Magazine (2025) shows that semiconductor shortages, high logistics costs, and persistent bottlenecks still profoundly impact OEM output capacity, even after the pandemic-induced disruptions have subsided (Hargreaves, 2025). Complementary studies emphasize that geopolitical instability — such as U.S. — China trade tensions or conflict-driven disruptions — further intensifies the vulnerability of globally distributed automotive supply chains (Tarannum & Zghair, 2024). These patterns demonstrate that the classical assumption of stable, just-in-time flows is increasingly untenable.

Recent academic analyses also highlight that resilience-building is no longer optional. Automakers are moving toward “nearshoring” and structural diversification to reduce dependency on single-region suppliers, as evidenced in 2025 industry evaluations of global supply chain reconfiguration (Putri, 2025). These shifts correspond with a growing body of literature proposing integrated frameworks combining technological solutions, supplier certification models, and big data analytics to enhance adaptability and operational continuity (Chapman & Ward, (2003).

Furthermore, new studies point out that hybrid risk-management models — merging traditional project-based risk assessment with agile-inspired adaptive mechanisms — can significantly improve responsiveness to short innovation cycles and fluctuating customer expectations (Askarpour et al., 2024). Agile principles enable faster detection of emerging issues and reduce uncertainty around evolving software-driven vehicle architectures, which is increasingly vital in modern automotive development ecosystems.

3. Methodology

3.1. Research objectives and questions

The research work is focusing on the following questions. The general objective is to get understanding by empirical data on the different risk practices.

- What are the major opinions of automotive experts regarding project risks?
- Is there a major opinion group with common agreement in certain risks?
- What is the effect of different grouping factors on the assessment?
- What are the most frequent risk mitigation actions?

3.2. Research design

Q-methodology is an approach to evaluate different opinion groups within a set of responses. It combines qualitative and quantitative methods based on factor analysis (Stephenson, 1935). It is designed to provide insights on complex, sometimes subjective topic, therefore optimal to use for our survey related to risk management opinions.

A so called Q-set has been developed with 36 statements of risk items (*Table 1*), originally from PMBOK (Project Management Institute, 2019) risk categories and modification by pilot studies. Four major risk source categories has been identified (Project Management; Organizational; Technical; External) along with the major project success dimensions (Cooke-Davies, 2002).

Table 1
Q-sort statements

Risk Category / Success Criteria	Project Management	Organizational	Technical	External
Good Sponsor	Uncontrolled changes in project scope	Reorganization within the company	Use of outdated methods or tools	Economic downturn affecting funding
	Project deadlines not being met	Power struggles among key stakeholders	Technical challenges beyond team's expertise	Political instability impacting project approval
	Lack of stakeholder communication and involvement	Misalignment with organizational goals	Infrastructure or equipment failures	Market shifts affecting project relevance
Good Team	Lack of skilled team members	Misallocation of project resources	System or equipment performance issues	Key partners or suppliers facing difficulties
	Miscommunication among team members	Inadequate team training and support	Defects in products or services	Natural disasters disrupting supply chains
	Errors in project scheduling and budgeting	Conflicts and poor collaboration within the team	Technological advancements requiring updates	Changes in regulations impacting project operations
Good Place	Lack of consistent project management practices	Implementation of conflicting policies	Cybersecurity breaches	Legal issues causing project delays
	Incomplete or unclear project documentation	Resistance to change within the organization	Loss of critical project data	Trade restrictions affecting materials or resources
	Inadequate project monitoring and control	Organizational changes disrupting the project	Persistent technical obstacles in daily work causing delays	Social unrest impacting project operations

We collected data between November 19, 2024 and February 7, 2025. PMI Budapest chapter helped us to reach project management professionals and we utilized internal project management network as well. Participants were asked to sort the 36 risk statements into a grid of quasi-normal distribution between -5 (least critical risk) and $+5$ (most critical risk). After completion of sorting we asked mitigation actions for the 3 highest rated risks and for the 1 lowest rated risk.

The sample includes 119 responses. Mostly aged between 30–59. 45% Hungarian, 14% German and others. Experience level shows appropriate variation, 27% has more than 20 years of experience. 63% has automotive industry experience. 52% prefers hybrid PM approached, 37% prefers plan-driven PM approaches.

3.3. Data analysis

Software used for analysis is Ken-Q Analysis Desktop Edition (KADE) 1.3.1. We applied principal component analysis (with Varimax rotation) and afterwards defined the number of factors based on

scree-plots. The analysis suggested 2 factors (however we made trials until 7 factors which didn't show increased explanation) – *Figure 1*.

To create a rank of the risk statements we calculated Z-scores. Based on grouping questions 4 groups has been defined: experience (<10 vs. >10 years), methodology (dedicated vs. hybrid), industry (automotive vs. non-automotive), and nationality (Hungarian vs. foreign).

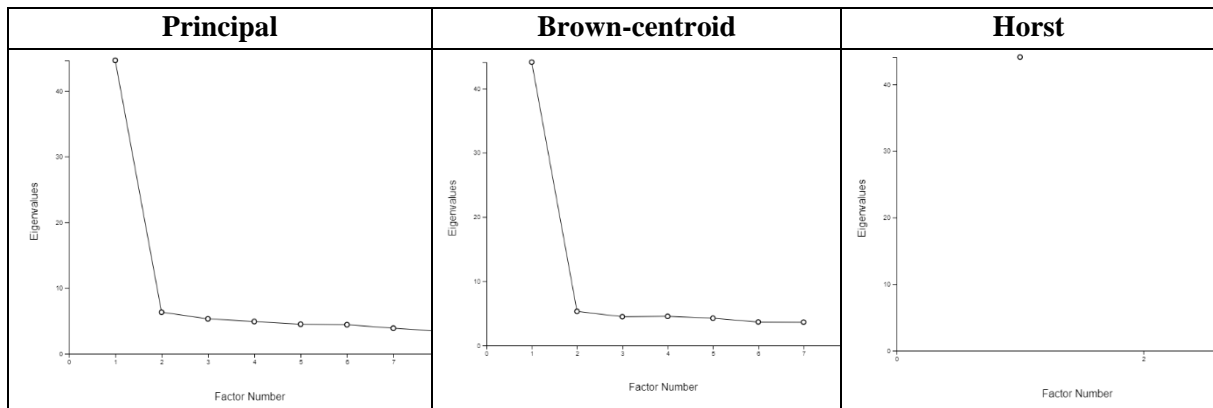


Figure 1. Scree-plot analysis with different methods

4. Results

4.1. Sample characteristics

Sample characteristics shown on *Table 2*, which generally shows us a diverse picture on the dataset. We have different input from wide range of age, nationality, experience, industry and PM approach.

Table 2
Sample characteristics

Grouping factor		Number	% sample
Age	<30 years	5	4%
	30–39 years	40	34%
	40–49 years	30	25%
	50–59 years	34	29%
	60+ years	10	8%
Nationality	Hungarian	53	45%
	German	17	14%
	Brazil	9	8%
	USA	7	6%
	Mexican	7	6%
	Indian	5	4%
	Spanish	4	3%
	Egyéb	17	14%
Project management experience	<5 years	21	18%
	5–10 years	31	26%
	11–15 years	22	18%

	Grouping factor	Number	% sample
Industry	16–20 years	13	11%
	+20 years	32	27%
	Automotive	75	63%
	IT	18	15%
	Production	4	3%
	Constucion	3	3%
	Telecommunications	3	3%
	Education	2	2%
	Consultancy	2	2%
	Other	2	2%
Preferred PM approach	Hybrid	62	52%
	Plan-based	44	37%
	Iterative	13	11%

4.2. Risk perception patterns

Z-score values represented on Table 3 shows the overall rank of the 36 risk statements. Highest rating received for *Project deadlines not being met*: 1.630; *Miscommunication among team members*: 1.461 and *Uncontrolled changes in project scope*: 1.305.

If we check the top 10 risk statements we can observe majority of them belongs to *Project management* category (communication, deadlines, scope, documentation, resources). In contracts, external factors received the lowest values like cybersecurity issues, natural disasters or political instability. Summary evaluation of 4 risk source categories, in the order of their overall rank based on Z-score evaluation:

- *Project management*:
 - Highest scores received. Which means this is in the focus on project risk sources.
- *Organizational risks*:
 - Medium scores received. Some elements received higher scores (lack of organizational target setting; resistance to changes), some of them received lower scores (organization structure).
- *Technical risk*:
 - Medium scores received. Some elements received higher scores (product quality), some of them received lower scores (technological updates).
- *External risks*:
 - Low scores received. Which means this is outside of the focus on project risk sources.

Some general patterns can be recognized across the assessment:

- *Time management*: major problem with projects, which indicates timing as the most important project target as well risk items related to timing has the highest attention.
- *Communication*: stakeholder engagement, teamwork, communication all ranked with high priorities, therefore even in the time of digitalization and AI the individual connections seems key.
- *Internal focus*: highest focus on internal items which the project team can directly impact rather than external risks which is outside of project teams' control.
- *Cybersecurity discrepancy*: one of the lowest rated category, which is interesting considering we are living in the age of digitalization where the probability of cybersecurity breaches are increasing
 - potential blindspot.

Table 3
Statement order for the whole sample with 1 Factor

Project Management	Organizational	Technical	External
#	Statement	Z-score	Q Sort value
20	Project deadlines not being met	1.63	5
18	Miscommunication among team members	1.461	4
19	Uncontrolled changes in project scope	1.305	4
21	Lack of stakeholder communication and involvement	1.256	4
25	Errors in scheduling and budgeting	1.246	3
27	Insufficient project monitoring and control	1.231	3
33	Conflicts and weak collaboration within the team	1.153	3
26	Incomplete or unclear project documentation	1.08	3
23	Incorrect allocation of project resources	0.761	2
22	Lack of skilled team members	0.74	2
24	Lack of consistent project management practices	0.687	1
28	Resistance to change within the organization	0.634	1
32	Insufficient team training and support	0.539	1
36	Organizational changes during the project	0.384	1
30	Lack of alignment with organizational goals	0.34	1
4	Lack of key partners or suppliers	0.294	0
5	Restructuring within the company	0.184	0
29	Power struggles among key stakeholders	0.022	0
14	Errors in products or services	0.014	0
11	Technical challenges beyond the team's expertise	-0.05	0
1	Economic downturn affecting project funding	-0.166	-1
16	Persistent technical issues causing daily delays	-0.258	-1
13	System or equipment performance issues	-0.27	-1
15	Use of outdated methods or tools	-0.347	-1
17	Loss of critical project data	-0.402	-1
34	Introduction of conflicting policies	-0.466	-1
3	Market changes affecting project relevance	-0.504	-2
12	Infrastructure or equipment failure	-0.531	-2
35	Technological advancements requiring updates	-0.989	-2
6	Regulatory changes affecting project implementation	-1.026	-3
8	Trade restrictions on materials or resources	-1.195	-3
7	Political instability affecting project approval	-1.478	-4
17	Legal issues related to the project	-1.539	-4
19	Cybersecurity incidents	-1.7	-4
9	Social unrest disrupting project operations	-1.796	-5
15	Natural disasters disrupting the supply chain	-2.026	-5

As mentioned earlier we simulated until 7 Factors, but after 2 Factors there were no significant changes in the explaining power of the sample. 2 Factors explains 48% of the variance which is acceptable. Factor 1 (n = 64; eigenvalue = 32.5) more focused on operational risks and teamwork (*Figure 2*). Factor 2 (n = 28; eigenvalue = 12.1) more focused on organizational topics and resistance to changes (*Figure 3*).

-5	-4	-3	-2	-1	0	1	2	3	4	5
5. Natural disasters disrupting supply chains	16. Cybersecurity breaches	** 6. Changes in regulations impacting project operations	** 34. Implementation of conflicting policies	** 10. Use of outdated methods or tools	** 11. Technical challenges beyond team's expertise	** 12. Inadequate team training and support	** 21. Lack of stakeholder communication and involvement	** 33. Conflicts and poor collaboration within the team	** 20. Project deadlines not being met	** 23. Miscommunication among team members
	** 9. Social unrest impacting project operations	** 2. Political instability impacting project approval	** 3. Market shifts affecting project relevance	** 28. Reorganization within the company	** 17. Loss of critical project data	** 4. Key partners or suppliers facing difficulties	** 25. Lack of consistent project management practices	** 24. Errors in project scheduling and budgeting	** 27. Inadequate project monitoring and control	
		** 7. Legal issues causing project delays	** 15. Technological advancements requiring updates	** 30. Misalignment with organizational goals	** 36. Organizational changes disrupting the project	** 31. Misallocation of project resources	** 21. Incomplete or unclear project documentation	** 19. Uncontrolled changes in project scope		
			** 8. Trade restrictions affecting materials or resources	** 29. Power struggles among key stakeholders	** 13. System or equipment performance issues	** 14. Defects in products or services	** 22. Lack of skilled team members			
				** 1. Economic downturn affecting funding	** 16. Persistent technical obstacles in daily work causing delays	** 35. Resistance to change within the organization				
					** 12. Infrastructure or equipment failures					

Figure 2. Factor 1 order (full sample; 2 factors)

-5	-4	-3	-2	-1	0	1	2	3	4	5
** 9. Social unrest impacting project operations	16. Cybersecurity breaches	** 2. Political instability impacting project approval	** 6. Changes in regulations impacting project operations	** 34. Implementation of conflicting policies	** 26. Incomplete or unclear project documentation	** 31. Misallocation of project resources	** 23. Miscommunication among team members	** 35. Resistance to change within the organization	** 19. Uncontrolled changes in project scope	** 21. Lack of stakeholder communication and involvement
	5. Natural disasters disrupting supply chains	** 7. Legal issues causing project delays	** 15. Technological advancements requiring updates	** 14. Defects in products or services	** 25. Lack of consistent project management practices	** 22. Lack of skilled team members	** 29. Power struggles among key stakeholders	** 24. Errors in project scheduling and budgeting	** 20. Project deadlines not being met	
		** 8. Trade restrictions affecting materials or resources	** 12. Infrastructure or equipment failures	** 18. Persistent technical obstacles in daily work causing delays	** 32. Inadequate team training and support	** 27. Inadequate project monitoring and control	** 33. Conflicts and poor collaboration within the team	** 30. Misalignment with organizational goals		
			** 17. Loss of critical project data	** 13. System or equipment performance issues	** 4. Key partners or suppliers facing difficulties	** 36. Organizational changes disrupting the project	** 28. Reorganization within the company			
			** 10. Use of outdated methods or tools	** 3. Market shifts affecting project relevance	** 1. Economic downturn affecting funding					
				** 11. Technical challenges beyond team's expertise						

Figure 3. Factor 2 order (full sample; 2 factors)

4.3. Subgroup analysis

Professionals with less than 10 years experience ($n = 56$) are focused on team skills and communications. Their colleagues with more than 10 years experience prioritized monitoring and control of scope, which could mean more experienced colleagues move their focus from human factors to process controls.

Ranking of the different subgroup Z-scores shown on *Figures 4–11* (see Appendix section), where the highest rated items appear on the right side of the Q-grid and the lowest rated items appear in the left side of the Q-grid.

Professionals preferring dedicated methods ($n = 57$) focused on internal operations (Factor 1 dominant), with lower correlation (0.68). Professionals preferring hybrid methodology ($n = 62$) rated stakeholder engagement more, with higher correlation (0.77).

Automotive experts ($n = 75$) prioritized internal dynamics, while non-automotive professionals ($n = 44$) focused more on organizational alignment, reflecting industry specific differences.

Hungarian professionals ($n = 54$) prioritized organizational resistance, meanwhile foreign experts ($n = 65$) prioritized team communication, indicating cultural differences on risk items.

4.4. Risk mitigation measures

389 risk mitigation measures has been received from the experts (average 12.2 actions / risk). Highest rated risks received more mitigation action proposals (for example project deadlines has been chosen most frequent in the Top 3 risks therefore the number of measures were the highest with total of 38 risk mitigation measures) – see *Table 4*.

Table 4
Risk mitigation measures frequency categorization

#	Risk factor name	Frequency	Most frequent risk mitigation measures	# of measures
s20	Project deadlines not being met	32	Detailed planning and monitoring (18), Incorporating buffer time (9), Setting realistic deadlines (11)	38
s23	Misunderstandings among team members	24	Regular meetings (14), Clear communication rules (8), Team building (7)	29
s19	Uncontrolled changes in project scope	22	Documenting change management process (13), Establishing change management committee (5), Impact analysis before changes (8)	26
s24	Errors in project scheduling and budgeting	22	Using experience from previous projects (10), Involving experts (8), Including reserves (9)	27
s21	Lack of stakeholder communication and involvement	17	Identifying and involving stakeholders (9), Creating communication plan (7), Regular updates (6)	22
s27	Inadequate project monitoring and control	17	Defining KPIs (8), Using automated tracking tools (5), Regular status evaluations (11)	24
s35	Resistance to change within the organization	14	Training and awareness (7), Communicating reasons for change (6), Ensuring executive support (4)	17
s33	Conflicts and poor collaboration within the team	13	Team building (6), Defining common goals and KPIs (5), Clarifying roles and responsibilities (7)	18
s26	Incomplete or unclear project documentation	13	Using documentation templates (5), Applying documentation checklists (4), Allocating more time for documentation (7)	16
s1	Economic downturn affecting funding	11	Creating budget reserves (7), Alternative scenarios (5), Continuous monitoring of economic situation (3)	15

#	Risk factor name	Frequency	Most frequent risk mitigation measures	# of measures
s28	Internal company restructuring	9	Ensuring documentation and knowledge transfer (5), Planning adequate handover time (4), Applying change management processes (3)	12
s13	System or equipment performance issues	9	Continuous monitoring (4), Regular maintenance (3), Testing and validation (5)	12
s22	Lack of skilled team members	9	Training programs (6), Mentoring (4), Selecting appropriate team members (5)	15
s30	Deviation from organizational goals	8	Alignment with leadership (5), Aligning project goals with organizational goals (6), Regular feedback (3)	14
s31	Misallocation of project resources	8	Resource planning (5), Clear roles and responsibilities (4), Prioritization (3)	12
s29	Power struggles among key stakeholders	7	Executive intervention (4), Defining common goals (5), Clear decision-making authority (3)	12
s14	Errors in products or services	7	Applying quality assurance system (5), Proactive actions (4), Thorough testing (5)	14
s4	Difficulties with key partners or suppliers	6	Thorough supplier evaluation (4), Using multiple suppliers (4), Increased oversight (3)	11
s11	Technical challenges beyond team expertise	6	Training (4), Involving external experts (3), Early risk analysis (3)	10
s25	Inconsistent project management practices	6	Standardized project management methodology (5), Training (4), Process control (3)	12
s2	Political instability affecting project approval	5	Risk analysis (3), Transparency (2), Independence (1)	6
s3	Market changes affecting project relevance	5	Market analysis (3), Flexibility in project scope (2), Developing new offerings (2)	7
s10	Use of outdated methods or tools	5	Modernization (3), Process improvement (3), Training (2)	8
s32	Inadequate team training and support	5	Mentoring program (3), Training (3), Knowledge transfer (2)	8
s36	Organizational changes disrupting the project	5	Clear communication (3), Building flexibility (2), Standardized workflows (2)	7
s16	Cybersecurity issues	3	Involving security experts (2), Security procedures (2), Monitoring (1)	5
s17	Loss of critical project data	3	Backup (3), Data sharing with team members (2), Business continuity plan (1)	6
s34	Introduction of conflicting policies	3	Reviewing organizational structure (2), Harmonization (2), Alignment with corporate goals (1)	5
s5	Natural disasters disrupting supply chains	2	Risk reduction (1), Preparedness (1)	2
s6	Regulatory changes affecting project operations	2	Redefining project goals (1), Involving legal experts (1)	2
s7	Legal issues delaying the project	2	Reducing regulations (1), Involving legal experts (1)	2
s8	Trade restrictions affecting materials or resources	2	Early identification of long lead items (1), Setting realistic target dates (1)	2
s9	Social unrest affecting project operations	1	(No specific recommendations)	0
s12	Infrastructure or equipment failure	1	Tracking issues and mitigation measures (1)	1
s15	Technological developments requiring updates	1	(No specific recommendations)	0
s18	Persistent technical obstacles causing delays	1	Good corporate culture and effective production management system (1)	1

Overall categories (*Table 5*) show: Deadline management (14.6%), communication improvement (8.9%), estimation planning (8.9%), change management (8.5%), monitoring (7.8%).

Table 5
Risk mitigation measures by categories

#	Category name	Frequency	%	Cum. %
s20	Managing Deadlines and Scheduling	41	14.6%	14.6%
s23	Improving Communication	25	8.9%	23.5%
s24	Improving Estimation and Planning Processes	25	8.9%	32.4%
s19	Effective Change Management	24	8.5%	40.9%
s27	Project Monitoring and Control	22	7.8%	48.8%
s21	Stakeholder Engagement	17	6.0%	54.8%
s33	Teamwork Development	16	5.7%	60.5%
s26	Improving Documentation	15	5.3%	65.8%
s14	Strengthening Quality Assurance	13	4.6%	70.5%
s22	Providing Adequate Training	13	4.6%	75.1%
s35	Culture of Change Management	13	4.6%	79.7%
s1	Budget Planning and Control	11	3.9%	83.6%
s25	Project Methodology Development	11	3.9%	87.5%
s30	Aligning Organizational Goals	8	2.8%	90.4%
s31	Resource Management	8	2.8%	93.2%
s29	Managing Conflicts of Interest	7	2.5%	95.7%
s4	Supplier Relationship Management	6	2.1%	97.9%
s28	Managing Organizational Changes	6	2.1%	100.0%
Total		281	100.0%	

Sub-tables derived from overall results provide specific suggestions. For deadline management, realistic scheduling received 34.1%, contingency buffers 22% (*Table 6*).

Table 6
Risk mitigation sub-measures by key category

Sub-category	Frequency	%	Cum. %
Defining Realistic Deadlines	14	34.1%	34.1%
Incorporating Buffer Time	9	22.0%	56.1%
Regular Review and Monitoring	8	19.5%	75.6%
Proper Allocation of Resources	7	17.1%	92.7%
Proper Task Breakdown	3	7.3%	100.0%
Total	41	100.0%	

For the lowest-rated risks, planning (25.3%) and diversification (15.8%) dominated suggested approaches (*Table 7*).

Table 7
Risk mitigation sub-measures by lowest rated category

#	Type of mitigation measure	Frequency	%	Cum. %
1	Planning and Preparation	24	25.3%	25.3%
2	Supplier Diversification	15	15.8%	41.1%
3	Cybersecurity Development	12	12.6%	53.7%
4	Involvement of Legal Experts	9	9.5%	63.2%
5	Risk Analysis	8	8.4%	71.6%
6	Training and Awareness	6	6.3%	77.9%

#	Type of mitigation measure	Frequency	%	Cum. %
7	Monitoring and Tracking	5	5.3%	83.2%
8	Other Measures	5	5.3%	88.5%
9	Location Review	4	4.2%	92.7%
10	Insurance	3	3.2%	95.9%
11	Budgetary Measures	2	2.1%	98.0%
12	Stockpiling and Reserves	2	2.1%	100.0%
	Total	95	100%	

5. Discussion

Based on our observations it is clear that current risk patterns are concentrated around time pressure. As a consequence the mitigation actions are also mostly related to actions related to time management.

Analysis of sub-groups revealed some differences. Supporters of hybrid PM approaches tends to focus on stakeholder management and flexibility which is in line with the basic values of agile philosophy.

The results are in line with the academic literature in regards of the importance of time management and communication, however a more detailed risk management methodology could be useful to take into consideration the sub-group preferences. This could lead to a more adaptive risk management approach which is especially important take into consideration the agile development directions in automotive industry. Our research reveals three key insights for automotive project risk management:

Internal versus External Risk Prioritization:

Automotive professionals prioritize internal, controllable factors over external risks. Project management practices, team dynamics, and organizational alignment dominate their concerns, while geopolitical events, natural disasters, and even cybersecurity receive less attention. This pattern reflects risk management's focus on actionable areas, however it may forecast a vulnerability given increasing global supply chain interdependencies, complexity and cyber threats.

Experience-Based Perspective Evolution:

Professional experience shapes how people think about risk. Less experienced professionals focus on immediate operational topics – team skills and efficient, direct communication. More experienced professionals take a wider view including external factors, organizational dynamics, systems and processes. This evolution suggests risk management training should focus from operational to strategic perspectives as professionals advance in their careers.

Methodological Approach Influence:

Supporters of dedicated methodologies (only agile or only waterfall) show more polarized opinions than hybrid approach supporters. Hybrid approach supporting professional take into consideration wider risk portfolio, potentially positioning them better for dynamic, agile automotive environments.

This study has certain limitations. High portion of the sample is from Hungary and the automotive sector, which may limit generalizability. Self-reporting can introduce inaccuracies, and Q-methodology itself is partially subjective. Future research could use longitudinal studies to understand how different strategies actually work over time, or compare our findings with samples from non-European regions.

5.1. Practical implications

For Project Managers:

- Prioritize deadline management through realistic planning, buffer implementation, and continuous monitoring – this is the universally recognized top issue.
- Create formal change management processes early in projects, due to that scope change ranks as a high-priority risk.
- Invest in communication processes and training that addresses both team-internal and stakeholder-external dimensions.
- Develop monitoring systems for KPIs, including regular reviews, and tracking tools.

For Organizations:

- Address bureaucracy issues, as this is one of the key barrier towards more agile organization.
- Define crystal-clear priorities and responsibilities within the different organizational levels.
- Provide experience-based training: operational focus for junior staff, strategic focus for senior professionals.

For Risk Management Programs:

- Balance internal focus with external awareness: internal operational risks seems obvious, however organizations should avoid blind spots regarding cybersecurity, geopolitical instability, and supply chain vulnerabilities.
- Tailored approaches based on maturity of organization: dedicated methodology organizations may require different approaches than hybrid practitioners.
- Leverage cultural strengths: Hungarian professionals' process control and international colleagues' planning practices represent wider capabilities in global teams.

5.2. Limitations and future research

Several limitations should be considered when interpreting the findings. First, geographic and industry concentration affects our sample, 45% of participants were Hungarian, and 63% works in automotive. Self-selected participation may introduce response bias.

Methodologically, Q-methodology identifies patterns but doesn't measure precise magnitudes of perception. The 2 factor solutions explained 43–53% of variance, leaving some unexplained variation. The current study captures a snapshot of the actual status, not tracking the evolution of organizational risk perspectives.

Future research should address these limitations. Longitudinal studies could discover how risk patterns evolve as organizations move towards agile transformations. Expanding geographic scope, particularly to include Asian automotive markets, would add value given their different product lifecycle patterns. Quantitative validation of mitigation measure effectiveness would strengthen practical guidance. Case studies could explore how identified risk patterns correlate with actual project success and targets. Finally, cultural comparison of Hungarian, Polish, German, and Asian professional using matched samples would provide better insights to understand global cultural patterns.

6. Conclusion

The main conclusion of the study that time pressure and communications are key aspects of (project) risk management. Our study used Q-methodology to identify opinion groups (Factors) across automotive professionals. Mitigation measures prioritizes planning and monitoring. The findings can provide practical implementations by using the project risk map as the outcome of the research.

Furthermore the research shows by sub-group analysis that risk perception is different based on experience, methodological preference, industry and nationality. Certain universal patterns discovered in the data, like the importance of time pressure and management or communication importance, however the variation between the sub-groups could help to better fine-tune risk mitigation strategies.

Automotive industry will become more and more complex due to the current trends of product development, digitalization, supply chain disruptions, which underlines the growing importance of project risk management and risk management projects.

This research provides understanding to develop differentiated risk management strategies to the companies' specific contexts while highlight universal priorities across the global automotive professional community.

Appendix

-5	-4	-3	-2	-1	0	1	2	3	4	5
** ◀ 5. Natural disasters disrupting supply chains	** ◀ 7. Legal issues causing project delays	** ▶ 16. Cybersecurity breaches	** ▶ 15. Technological advancements requiring updates	** ▶ 12. Infrastructure or equipment failures	30. Misalignment with organizational goals	35. Resistance to change within the organization	** ◀ 24. Errors in project scheduling and budgeting	23. Miscommunication among team members	** ▶ 33. Conflicts and poor collaboration within the team	20. Project deadlines not being met
9. Social unrest impacting project operations	** ◀ 6. Changes in regulations impacting project operations	** ▶ 1. Economic downturn affecting funding	** ▶ 28. Reorganization within the company	** ▶ 31. Misallocation of project resources	** ▶ 10. Use of outdated methods or tools	25. Lack of consistent project management practices	** ▶ 32. Inadequate team training and support	** ▶ 22. Lack of skilled team members		
	** ◀ 2. Political instability impacting project approval	** ▶ 34. Implementation of conflicting policies	** ▶ 17. Loss of critical project data	** ▶ 26. Incomplete or unclear project documentation	** ▶ 14. Defects in products or services	** ▶ 27. Inadequate project monitoring and control	** ▶ 19. Uncontrolled changes in project scope			
		8. Trade restrictions affecting materials or resources	** ▶ 3. Market shifts affecting project relevance	** ▶ 36. Organizational changes disrupting the project	** ▶ 18. Persistent technical obstacles in daily work causing delays	** ▶ 21. Lack of stakeholder communication and involvement				
			29. Power struggles among key stakeholders	** ▶ 13. System or equipment performance issues	** ▶ 11. Technical challenges beyond team's expertise					
				** ▶ 4. Key partners or suppliers facing difficulties						

Figure 4. Factor 1 order (shorter experience; 2 factors)

-5	-4	-3	-2	-1	0	1	2	3	4	5
** ◀ 16. Cybersecurity breaches	** ◀ 2. Political instability impacting project approval	** ▶ 6. Changes in regulations impacting project operations	** ▶ 34. Implementation of conflicting policies	13. System or equipment performance issues	14. Defects in products or services	31. Misallocation of project resources	26. Incomplete or unclear project documentation	33. Conflicts and poor collaboration within the team	** ▶ 27. Inadequate project monitoring and control	** ▶ 23. Miscommunication among team members
	** ▶ 5. Natural disasters disrupting supply chains	** ▶ 7. Legal issues causing project delays	** ▶ 3. Market shifts affecting project relevance	** ▶ 12. Infrastructure or equipment failures	** ▶ 30. Misalignment with organizational goals	** ▶ 32. Inadequate team training and support	24. Errors in project scheduling and budgeting	** ▶ 21. Lack of stakeholder communication and involvement	** ▶ 20. Project deadlines not being met	
	** ▶ 9. Social unrest impacting project operations	** ▶ 15. Technological advancements requiring updates	18. Persistent technical obstacles in daily work causing delays	11. Technical challenges beyond team's expertise	35. Resistance to change within the organization	25. Lack of consistent project management practices	** ▶ 19. Uncontrolled changes in project scope			
		8. Trade restrictions affecting materials or resources	** ▶ 1. Economic downturn affecting funding	** ▶ 28. Reorganization within the company	** ▶ 4. Key partners or suppliers facing difficulties	22. Lack of skilled team members				
			10. Use of outdated methods or tools	** ▶ 17. Loss of critical project data	** ▶ 36. Organizational changes disrupting the project					
				** ▶ 29. Power struggles among key stakeholders						

Figure 5. Factor 1 order (longer experience; 2 factors)

-5	-4	-3	-2	-1	0	1	2	3	4	5
16. Cybersecurity breaches	7. Legal issues causing project delays	6. Changes in regulations impacting project operations	29. Power struggles among key stakeholders	10. Use of outdated methods or tools	13. Persistent technical obstacles in daily work causing delays	25. Lack of consistent project management practices	22. Lack of skilled team members	24. Errors in project scheduling and budgeting	23. Miscommunication among team members	20. Project deadlines not being met
	5. Natural disasters disrupting supply chains	2. Political instability impacting project approval	3. Market shifts affecting project relevance	1. Economic downturn affecting funding	36. Organizational changes disrupting the project	31. Misallocation of project resources	33. Conflicts and poor collaboration within the team	19. Uncontrolled changes in project scope	27. Inadequate project monitoring and control	
		9. Social unrest impacting project operations	8. Trade restrictions affecting materials or resources	17. Loss of critical project data	17. Defects in products or services	4. Key partners or suppliers facing difficulties	22. Inadequate team training and support	21. Lack of stakeholder communication and involvement		
			15. Technological advancements requiring updates	12. Infrastructure or equipment failures	30. Misalignment with organizational goals	11. Technical challenges beyond team's expertise	26. Incomplete or unclear project documentation			
				34. Implementation of conflicting policies	28. Reorganization within the company	35. Resistance to change within the organization				
					33. System or equipment performance issues					

Figure 6. Factor 1 order (dedicated methods group; 2 factors)

-5	-4	-3	-2	-1	0	1	2	3	4	5
5. Natural disasters disrupting supply chains	16. Cybersecurity breaches	7. Legal issues causing project delays	17. Loss of critical project data	11. Technical challenges beyond team's expertise	29. Power struggles among key stakeholders	26. Incomplete or unclear project documentation	25. Lack of consistent project management practices	23. Miscommunication among team members	13. Uncontrolled changes in project scope	21. Lack of stakeholder communication and involvement
	9. Social unrest impacting project operations	12. Infrastructure or equipment failures	6. Changes in regulations impacting project operations	10. Use of outdated methods or tools	32. Inadequate team training and support	30. Misalignment with organizational goals	33. Conflicts and poor collaboration within the team	27. Inadequate project monitoring and control	22. Project deadlines not being met	
		2. Political instability impacting project approval	15. Technological advancements requiring updates	14. Defects in products or services	34. Implementation of conflicting policies	35. Resistance to change within the organization	31. Misallocation of project resources	24. Errors in project scheduling and budgeting		
			8. Trade restrictions affecting materials or resources	3. Market shifts affecting project relevance	1. Economic downturn affecting funding	22. Lack of skilled team members	36. Organizational changes disrupting the project			
				13. System or equipment performance issues	4. Key partners or suppliers facing difficulties	38. Reorganization within the company				
					16. Persistent technical obstacles in daily work causing delays					

Figure 7. Factor 1 order (hybrid methods group; 2 factors)

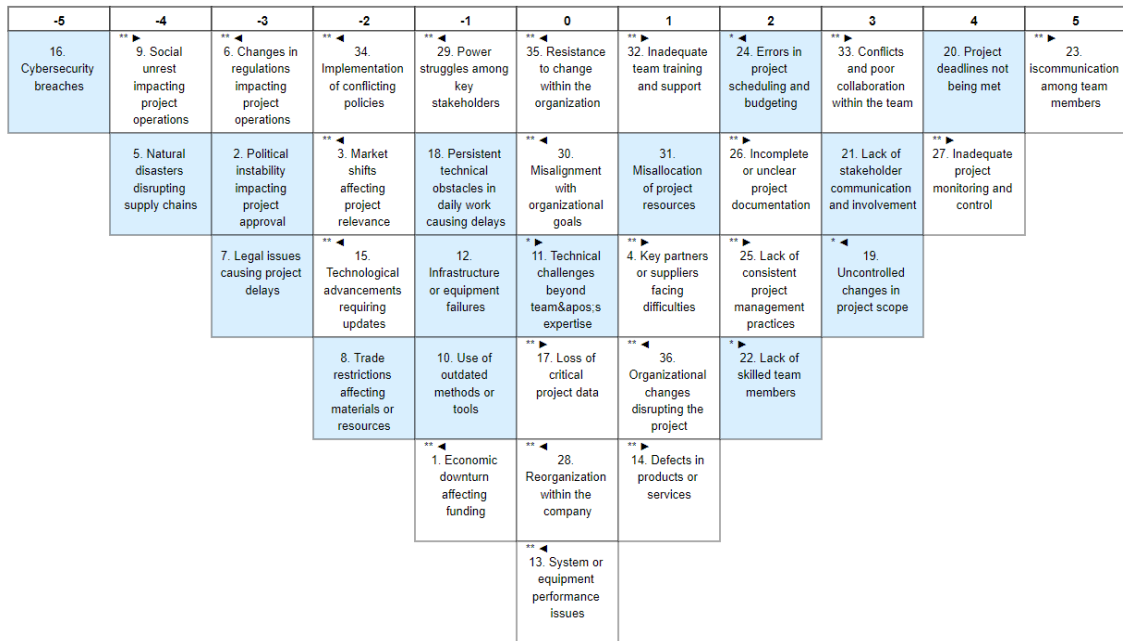


Figure 8. Factor 1 order (automotive; 2 factors)

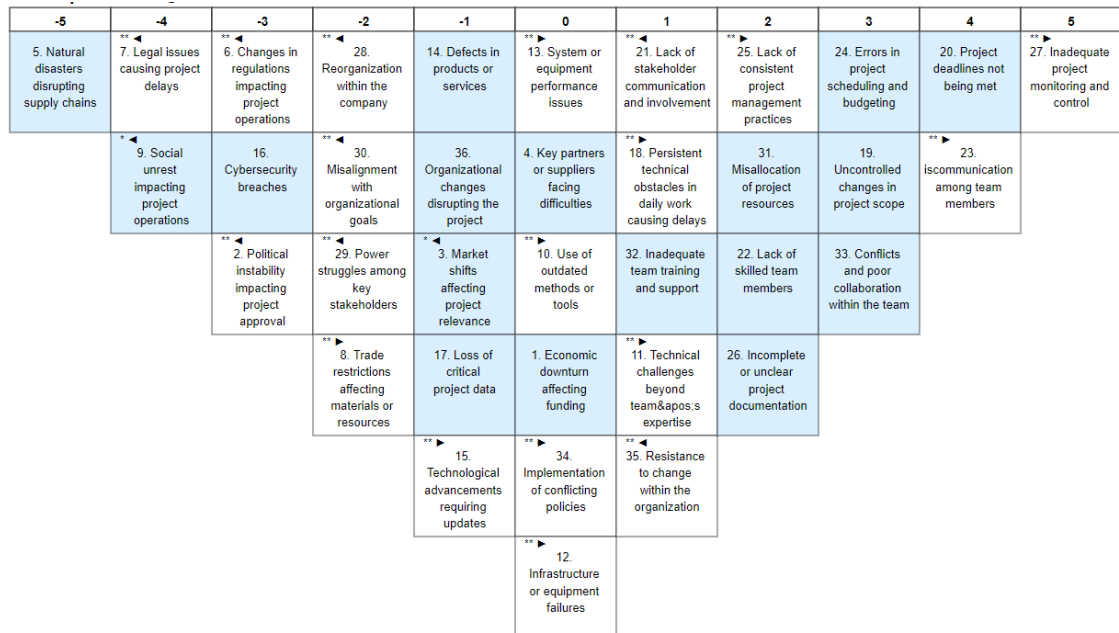


Figure 9. Factor 1 order (other industries; 2 factors)

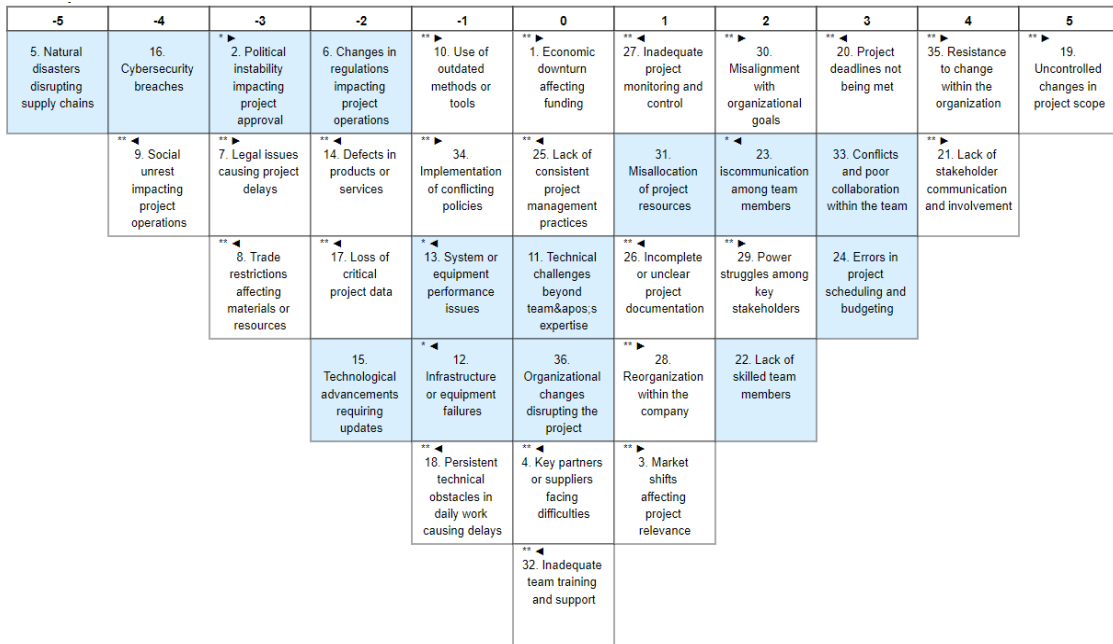


Figure 10. Factor 1 order (Hungarians; 2 factors)

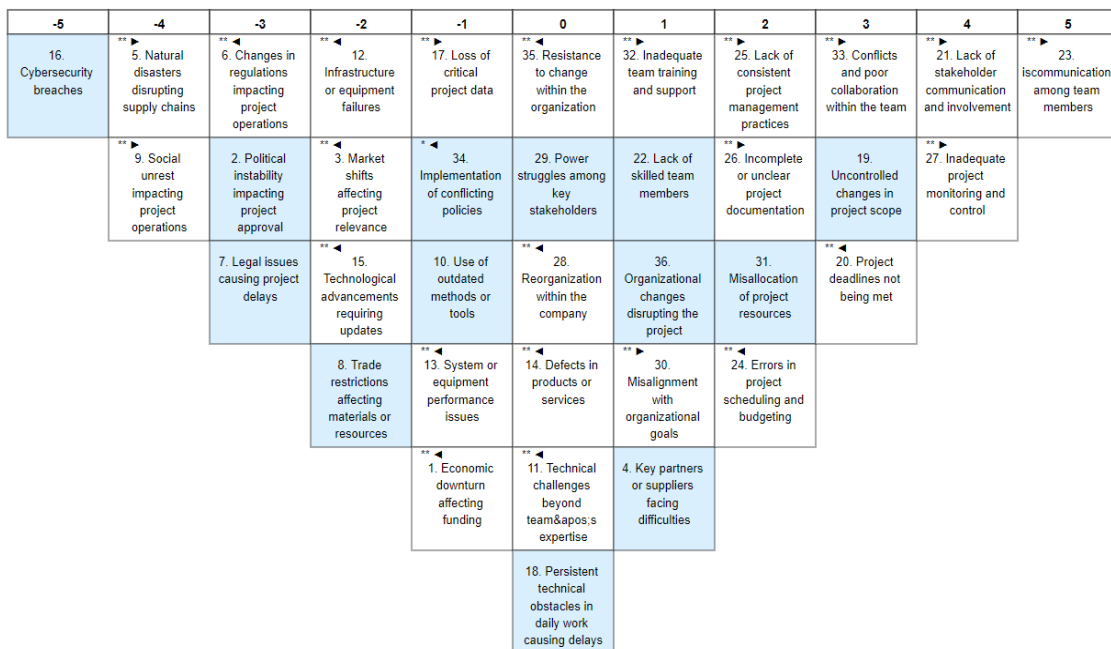


Figure 11. Factor 1 order (other nations; 2 factors)

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