Managing Delays in the Construction of the East-West Highway in Algeria : Risk Analysis and Prospects for a Sustainable Sector

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Abstract**—**Road infrastructure is continuously adapting to major social, economic and environmental transformations. However, delays in the execution of the East-West Highway in Algeria illustrate the complexity of such large-scale projects. Statistical analysis based on a Relative importance index was used to analyze and priorities the risks of delay. This study focuses on the perspectives of the Project Owner, the Project Manager and the contractor in order to measure the importance of 59 delay factors. In all, 25 valid responses were collected and analyzed, highlighting discrepancies in risk perception. The results identified the main risks, such as unrealistic contract duration, slow change orders, slow variation orders in excess quantities, delay in payment for work performed, and work starting before design completion. The study also reveals that delays reach 100% of the initial expected time. From a theoretical point of view, this work sheds light on the risk dynamics in emerging economies. In addition, it offers important practical recommendations for decision-makers and stakeholders in Algeria and elsewhere, aimed at strengthening the resilience and sustainability of the construction sector.

Keywords**—**Delay Factors, Emerging Economies, Risk Management, Road Infrastructure.

I. Introduction

Delay is a common risk in construction projects. Systematic delay management ensures that the cause of these delays will be identified and documented as soon as possible. Delays are detrimental to both the Project Owner and the Contractor. Delays occur due to many factors and variables from different sources which include but are not limited to stakeholder performance, contractual relationships and the project environment [1]. Construction delays must be resolved promptly by allocating responsibilities between the parties in a fair and appropriate manner [2]. Several researchers conducted literature reviews to provide an updated compilation of previous studies dealing with the ranking of causes of delay. Durdyev and Hosseini [3] conducted a systematic review of studies published between 1985 and 2018, identifying a total of 149 causes of delay across 97 selected studies. Viles et al. [4], meanwhile, examined 47 studies published between 1985 and 2017 on a global scale to identify the most frequent and important causes of delay. Sanchez-Cazorla et al.[5] proposed a risk categorization based on 9 homogeneous categories encompassing all types of identified risks, while Prasad and Vasugi [6] highlighted common causes of delay in developed and developing economies, highlighting external factors and financing difficulties. An in-depth analysis was also carried out by Zidane and Andersen [7], comparing the main delay factors in large Norwegian projects with the universal delay factors. Ramanathan et al. [8] concluded that each study is unique and delay factors vary by country, location, and project. In addition, country-specific research on the causes of delays has been carried out, such as that carried out by Heravi and Mohammadian [9] in Iran, or Kog [10] in Singapore. Finally, research has explored specific causes of delays related to communications management, claims management and the shortage of skilled labour, highlighting the importance of these factors in the quality of construction projects and their impact on the schedule and budget. The evaluation of Algerian highway projects has many objectives and is notably linked to learning, sharing and knowledge transfer [11].

II. Research Methodology

The research method used aims to collect data from a large sample, so we selected people on the basis of their experience in carrying out complex and structuring projects. The survey was organized as a questionnaire to guide the interviews, responses from which can be easily collected and analyzed. The questionnaire included an ordinal measurement scale (Likert scale from 0 to 4).

Risk exposure is defined as follows [12] - [13]:

$$\text{Risk exposure} = \sum_{i=1}^{n} \boldsymbol{P}(RI_i) \times \boldsymbol{M}(RI_i) \quad (1)$$

Where $P(RI_i)$ is the probability of an undesirable outcome i, and $M(RI_i)$ is the magnitude of the loss due to the undesirable outcome i. This definition, like that proposed by classical risk theory [14], does not consider positive outcomes to be "risky" and refers only to the key elements of the concept of risk, namely the harmful consequence and the possibility of this consequence occurring.

The combination of the probability of occurrence and the magnitude of the consequences of the risk on the project objectives makes it possible to measure and judge the criticality of an identified risk in relation to others.

The following formulas were used to calculate the different indices [15]:

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Relative Importance

$$RI = \sum_{i=1}^{n} \boldsymbol{P}(RI_i) \times \boldsymbol{M}(RI_i) \quad (1)$$

Probability of occurrence

$$\boldsymbol{P}(\boldsymbol{RI_i}) = \frac{1}{4} \times \sum_{i=1}^{4} \boldsymbol{Wp_i} \times (\frac{n_i}{N}) \times \mathbf{100}(\%) \quad (2)$$

Where Wpi is the constant weight given to each answer (0 for ever up to 4 for ever), ni is the probability of the ith answer and N is the total number of answers.

Magnitude of the consequences [4]

$$\boldsymbol{M}(RI_i) = \frac{1}{4} \times \sum_{i=1}^{4} Wm_i \times (\frac{n_i}{N}) \times 100(\%) \quad (3)$$

Where Wmi is the constant weight given to each answer (0 for negligible up to 4 for Extreme), ni is the magnitude of the ith answer and N is the total number of answers.

III. Results and Discussions

A. Characteristics of the population

Table I below summarizes the general information provided by respondents who participated in the survey.

TABLE I. DEMOGRAPHIC CHARACTERISTICS

Experience (Year)	Project Owner		Project Manager		Contractor	
	No	% Delay	No	% Delay	No	% Delay
10 to 19	3	80 - 100	1	40	4	40 - 50
20 to 29	5	40 - 50	5	70 - 100	0	0
30 and more	1	100	3	60 - 80	3	30
Total	9		9		7	

The results show that respondents are experienced (Table I). They reported experiencing delays in completed projects. A range of delay magnitudes was also reported by the respondents. For example, Table I shows that project owner respondents with more than 30 years of experience reported that the largest rate of delay for various completed projects was up to 100% of the original project duration.

B. Analysis of causes of delay

Probability, magnitude, and relative importance indices were used to rank the causes of delay from the perspective of the respondents. To analyze the causes of delay, Table II shows the relative importance index of each cause and the rank of the top 10 causes in the overall ranking obtained from the combined data of all respondents

C. Interactions of risk viewpoints

The results show that most of the top 10 causes of delays are shared by different categories of respondents. Table III shows the sharing of views obtained from the combined results of the different categories of actors.

Three causes of delay are shared by all parties, which are: Slow change orders, Slow variation orders in extra quantities and Slowness in reviewing and approving design documents by project owner.

TABLE II. DELAY CAUSES

ID	Causes of delay	Index	Rank
C11	Unrealistic contract duration	64,79	1
C17	Slow change orders	57,34	2
C212	Slow variation orders in extra quantities	55,07	3
C29	Delay in payment of performed work	54,06	4
C215	Work start before design completion	52,44	5
C15	Conflicts during work execution	51,88	6
C22	Slowness in reviewing and approving design documents by Project owner	51,29	7
C52	Conflicts due to incomplete understanding of client's requirements	50,87	8
C95	Long customs clearance procedures of imported products	50,87	8
C41	Slowness in reviewing and approving design documents by Project manager	50,87	8

TABLE III. INTERACTIONS OF RISK VIEWPOINTS

Causes of delay	17	212	22	11	215	29	52	41	15	95
Rank	2	3	7	1	5	4	8	8	6	8
Mutual agreement	PO - C- PM			PO - PM		PO - C	PM - C		PO	PM
Source of Risk	P	PO		P	PO	PO	D	PM	P	E

Legend : PO : Project Owner; PM : Project Manager ; C: Contractor ; P : Project ; D : Designer ; E : External.

Two causes are shared by the Project Owner and the Project Manager : Unrealistic contract duration and Work start before design completion.

Two other causes are shared by the Project Manager and the Cotractor : Conflicts due to incomplete understanding of client's requirements and Slowness in reviewing and approving design documents by project manager.

A cause of delay is shared by the Project Owner and the Contractor : Delay in the payment of performed work .

Finally, two causes are highlighted separately and respectively by the Project Owner and the Project Manager, namely: Conflicts during work execution and Long customs clearance procedures of imported products.

We can also see that the Project Owner is the first source of risk since he is responsible for 4 causes of delays among the 10 most important causes.

IV. Recommendations

Based on feedback from industry practitioners and construction industry experts, the study provides recommendations for reducing and preventing delays in construction projects:

Minimize changes during construction;

Have the client and contractor negotiate the completion time based on operational needs and resource availability;

Reduce administrative formalities and streamline decision making.

V. Conclusion

This research was conducted through questionnaires and individual interviews with experts and construction professionals to identify the main causes of delay in the construction projects of the East-West Algerian Highway. 59 causes of delay were collected and grouped into nine categories according to their sources of risk. The collected cases are then ranked according to their relative importance. A total of 25 valid answers were collected from 9 respondents of the project owner, 7 respondents of the contractors and 9 respondents of the project manager directly involved in the realization of the project. The results show that the maximum delay rate for various completed projects was up to 100%. The results highlight that most of the 10 most important causes of delay according to the overall importance index are shared by the different categories of actors. In fact, three causes of delay are shared by all stakeholders, namely: slow change orders, slow change orders for extra quantities, and slow review and approval of design documents by the project owner. The results also show that the project owner is the first source of risk, as he is responsible for 4 of the 10 most important causes of delay.

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References

[1] G. Sweis, R. Sweis, A. Abu Hammad, A. Shboul, "Delays in construction projects: the case of Jordan", *Int J Project Manage*., vol.26 no.6, pp. 665–674, 2008. Doi.org/10.1016/j.ijproman.2007.09.009. https://doi.org/10.1016/j.ijproman.2007.09.009

[2] B. A. K. S. Perera, M. K. C. S. Wijewickrama, P. J. A Goonawardana and Chandana Jayalath, "Improving the efficiency of delay notification process of construction projects in Sri Lanka", *International Journal of Construction Management*., vol.21 no.7, pp. 755-768, 2019. Doi. org/10.1080/15623599.2019.1581593 https://doi.org/10.1080/15623599.2019.1581593

[3] S. Durdyev, and M. R. Hosseini, "Causes of delays on construction projects: a comprehensive list", *International Journal of Managing Projects in Business*, vol.13 no.1, pp. 20-46. 2020 https://doi.org/10.1108/IJMPB-09-2018-0178

[4] E. Viles, N. C. Rudeli, and A. Santilli, "Causes of delay in construction projects : a quantitative analysis", *Engineering, Construction and Architectural Management*, vol.27 no.4, pp. 917-935, 2020. https://doi.org/10.1108/ECAM-01-2019-0024

[5] A. Sanchez-Cazorla, A. I. Diéguez, and A. I., Irimia-Dieguez, "Risk Identification in Megaprojects as a Crucial Phase of Risk Management : A Literature Review", *Project Management Journal*, January, vol.47 no.6, pp. 75-93, 2016. https://doi.org/10.1177/875697281604700606

[6] K. V. Prasad , and V. Vasugi, "Delays in construction projects : A review of causes, need and scope for further research", *Malaysian Construction Research Journal*, vol.23 no.3, pp. 89-113, 2017.

[7] Y. J.-T. Zidane, and B. Andersen , ."The top 10 universal delay factors in construction projects", *International Journal of Managing Projects in Business*, vol.11 no.3, pp. 650-672, 2018. https://doi.org/10.1108/IJMPB-05-2017-0052

[8] C. Ramanathan, S. Narayanan, and A. B. Idrus, "Construction delays causing risks on time and cost - A critical review", *Australasian Journal of Construction Economics and Building*, vol.12 no.1, pp. 37-57, 2012. https://doi.org/10.5130/AJCEB.v12i1.2330

[9] G. Heravi, and M. Mohammadian. "Investigating cost overruns and delay in urban construction projects in Iran", *International Journal of Construction Management*, vol.21 no.9, pp. 958-96, 2021. https://doi.org/10.1080/15623599.2019.1601394

[10] Y. C. Kog, "Project Management and Delay Factors of Public Housing Construction". *Practice Periodical on Structural Design and Construction*,. vol.23 no.1, February 2018.

[11] J-T. Zidane Youcef, Elvenes Bjørn Otto, F. Samset Knut and A. Hussein Bassam, "System Thinking, Evaluations and Learning-Experience from Road Construction Megaproject in Algeria", *Mediterranean Journal of Social Sciences*, vol.9 no.3, pp. 121–134. 2018. Doi. org - 10.2478/mjss-2018-0054 https://doi.org/10.2478/mjss-2018-0054

[12] B.W. Boehm, "Tutorial: Software risk management", *Washington, DC.: IEEEComputer Society Press*, 1989.

[13] H. Barki, S. Rivard, and J. Talbot, "Perspective and methods in risk assessment". *Cahier GreSI* no.93-07, September 1993.

[14] P.J.H. Schoemaker, "The expected utility model : Its variants, Purposes,evidence and limitations", *Journal of Economic Litterature*. no 20, pp. 529-563, 1982.

[15] R. Zemra, T. Boudouh,.and M. Baheddi, "Causes of schedule delays in construction projects in Algeria", *International Journal of Construction Management*, vol.19.5, 371-381, 2018. Doi.org/10.1080/15623599.2018.1435234.

Authors' Biographies

Rachid Zemra was born in Arris (Arris, Algeria) on December 17, 1965, and graduated as a State Building Engineer from the National School for Higher Training in Building Rouiba - Algiers (Algiers, Algeria) in 1989, followed by a Master's degree in Civil Engineering with a major in Soil Structure and Mechanics from the University of Mohamed Khider - Biskra (Biskra, Algeria) in 2003. He then completed a PhD in Risk Management in Construction Projects at the University of Batna (Batna, Algeria) in 2019.

He began his career as a SPECIALIZED PROFESSIONAL TEACHER, before taking up the position of ASSISTANT PROFESSOR in the Civil Engineering Department in 2007. Since 2019, he has been a LECTURER at the University of Batna. He has completed internships at the IRTES-M3M Laboratory at the University of Technology of Belfort - Montbéliard, 90010 Belfort cedex France. He has also completed a training course in “Training of Trainers and Pedagogical Engineering” at the University Institute for Master Training, Créteil - France.

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2-Rachid Zemra , Toufik Boudouh & Mohammed Baheddi (2019), "Causes of schedule delays in construction projects in Algeria", *International Journal of Construction Management*, 19 (5), 371-381.

His research interests focus on the managing the risks associated with construction project delays.