Article

Not peer-reviewed version

A Systematic Approach to Identify and Manage Interface Risks Between Project Stakeholders in Construction Projects

Michael Chuba Okika * , Andre Vermeulen , Jan-Harm Christiaan Pretorius

Posted Date: 27 July 2023

doi: 10.20944/preprints202307.1821.v1

Keywords: risks; project stakeholders; construction; project; interfaces; interface risks; construction projects; interface risk management

 doi:10.20944/preprints202307.1821.v1

Article

A Systematic Approach to Identify and Manage Interface Risks between Project Stakeholders in Construction Projects

Michael, C Okika *, 1, Andre Vermeulen 2 and Jan-Harm Christiaan Pretorius 2

1 Postgraduate School of Engineering Management, University of Johannesburg, South Africa
2 Faculty of Engineering and the Built Environment, University of Johannesburg, Johannesburg, South Africa
avermeulen.research@gmail.com (A. Vermeulen); jhcpretorius@uj.ac.za (JHC Pretorius).
* Correspondence: michaelieece@yahoo.co.uk or 219123868@student.uj.ac.za (M. Okika)

Abstract: Interface risks are inherent in every construction project from start to finish. Identifying and managing these risks effectively in every project phase is crucial for actualising project objectives. This paper shows a comprehensive framework showing several relationships between project stakeholders and how the interface risks between them that influence project execution are identified and managed for the overall construction project success. Firstly, literature review on interfaces and interface risks were carried out and how organisations managed interface risks were discussed and secondly, the collection of quantitative data was conducted by means of structured online questionnaires. The sample consisted of 205 construction project professionals who were selected randomly. This group included individuals with various roles in the construction industry, The data was analysed using descriptive statistical methods, including factor analysis, reliability assessment, and calculations of frequencies and percentages. Finally, the results showed all the factors, work culture and organisational approaches that influence interface risk management and ways to identify and manage interface risks effectively.

Keywords: interface risk management; project stakeholders; construction; risk; project; interfaces; interface risks; construction projects

---

1. Introduction

The construction industry encounters interface risks which are complex, difficult and diverse to solve and manage. interface risk management (IRM). Interface risks are the most encountered problem in the industry. In the highly risky and complex environment of a construction project, if effective decisions are not made in the conceptualisation, planning, design, contracting, procurement, execution phases, disagreements, loss of profit, claims, industrial actions, disputes, conflicts, change orders, and claims can occur at any phase of the construction project. The traditional construction industry usually depends on the project participants' work experiences to solve interface risks problems, including designers, owners, project team members, main contractors, subcontractors, host communities, licensing and regulatory bodies, vendors, maintenance contractors, and material suppliers related issues.

Interface risk management is primarily overseen and regulated by project managers. However, the intricate handling of these interface incidents is frequently evaluated and appraised based on the expertise of engineers. The involvement of a systematic approach to interface problems is infrequent. In essence, the conventional approach to interface problem solving lacks objectivity, relies heavily on subjective experiences, and lacks a systematic framework for identifying interface issues and proposing comprehensive solutions. The professionalisation of interface risk management (IRM) practise has been shown to have a positive impact on the project performance of construction projects [1]. This, in turn, leads to enhanced social benefits for public projects. While the advantages of Interface Risk Management (IRM) may be more readily apparent in large-scale projects, the effective management of interfaces is considered significant for projects of all sizes and levels of complexity. Furthermore, recent research conducted by [2,3] has revealed that project managers have utilised

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 27 July 2023 doi:10.20944/preprints202307.1821.v1

Building Information Modelling (BIM) to effectively oversee extensive construction projects and address the challenges associated with interfaces. In addition to its academic significance, this study also demonstrates its social relevance by potentially contributing to the professionalisation of IRM. The academic literature suggests that IRM holds promising benefits. One can anticipate several benefits from improving the exchange of information and reducing costs associated with interface issues, such as the promotion of inter-organizational collaboration [1,4].

Construction projects employ principles and protocols that encompass a multitude of complexities in the management of various stakeholders, including owners, technical clients, and engineering, procurement, and construction (EPC) contractors. The reason for this is that the phases of the construction project encompass numerous contracts that involve a diverse range of contractors. According to [5], therefore, it is important to recognise that the application of principles and approaches may vary among different stakeholders, both internal and external. Firstly, it is not feasible to effectively manage the relational connections between a singular project team consisting of the general contractor, client, designer and customer [6]. Furthermore, the premise of a singular project team is predicated on the explicit consideration of the individual interests and objectives of all the participants [7]. In practical application, the interests of the individuals engaged in a construction endeavour exhibit variation and frequently encompass multiple facets. This phenomenon arises in scenarios where the proprietor aims to reduce the expenses associated with construction, while the general contractor or subcontractor seeks to augment the construction costs. Additionally, the technical customer plans to delegate the tasks and coordination work to the design firm, thereby necessitating supplementary compensation [8]. According to [9], when considering the selection of the most economically efficient alternatives, the practicality of implementing a sole project team is questionable. The contractor expresses a favourable perspective regarding the evaluation of the most financially advantageous construction project. Nevertheless, the limited availability of construction orders to contractors can be attributed competition from other industry players and market conditions. The primary concern for customers is the fulfilment of technical construction orders. Interface risk management is commonly employed in intricate projects and overseen by multiple stakeholders with diverse areas of expertise, resulting in a multitude of overlapping activities. Interface risk management is a potential solution for effectively managing the complexities of construction projects. It primarily involves the management of communications, relationships, and deliverables among project stakeholders. By establishing improved methods for identifying, documenting, monitoring, and tracking project interfaces and the associated risks, interface risk management can contribute to the successful execution of construction projects. The present study undertakes a comprehensive review of relevant literature in order to establish a solid theoretical foundation for the research. The term "interfaces" in the context of construction projects refers to the points of connection or interaction between different components, systems, or stakeholders involved in the project. These interfaces play a crucial role in ensuring the successful coordination and integration of various elements within the construction process. Interfaces are significant for the overall project execution.

2. Background

2.1. Definition and Significance of Interfaces in Construction Projects

The concept of the interface was initially introduced by Wren, D.A. within the realm of organisational management. It was defined as the point of contact between interacting organisations that possesses a certain degree of autonomy. According to [10], there is a need to prioritise factors such as information sharing, degree of cooperation, and response time among organisational interfaces in construction projects. The concept of interface management encompasses the effective information management, coordination, and responsibility across contractual, physical and organisational boundaries. It is widely recognised as a valuable approach for fostering friendly collaboration between project organisations within the construction industry [11]. The effective management of interfaces in the construction industry is widely recognised as a socially oriented activity that extends beyond formal practises and procedures [4]. In the context of interface classification, [12] employed the term "internal" to denote interactions occurring exclusively within the confines of a single project environment. Conversely, the term "external" refers to relationships established with entities that have no direct involvement in the project. In a survey conducted by

 doi:10.20944/preprints202307.1821.v1

[12], a range of interface issues were identified by industry experts. These issues included permits, change orders, contract obligations, poor quality of works, government laws, environmental problems, long lead items, poor contracting strategy, and wrong specifications.

2.2. Interface Risk Management

According to [12], there exists a differentiation between interface management and integration management. Integration management primarily concerns itself with the coordination of various project elements, encompassing the associated processes. On the other hand, interface management primarily involves the identification of stakeholder points of contact and the associated risks. According to scholars in the construction industry, interface management is widely recognised as a means to enhance goal alignment, mitigate conflicts, and improve cooperation efficiency among participants. Considering the evident significance of systems thinking in addressing interfaces, it was anticipated that the existing body of general systems engineering (SE) literature would offer comprehensive information on the organisation of information management (IM). Contrary to the previous statement, the opposite holds true. The book authored by Hsu (2020) regarding the foundations of software engineering in industrial practise exhibits limited focus on the subject matter. The primary emphasis of this study pertains exclusively to physical interfaces, encompassing their identification using various tools and their management through control documents. Hence, it is comprehensible that scholars advocate for the formalisation of interface management through the implementation of a methodical approach. As a result, recent scholarly endeavours have predominantly concentrated on the advancement of formal governance approaches through the utilisation of standardised procedures and information technology [1,4]. According to [4], research indicates that individuals involved in projects lack a comprehensive understanding of the necessary components for proficiently managing interfaces. The implementation of practical guidelines has the potential to have a positive impact on individuals' behaviours towards interface management. Additionally, it can foster a collective comprehension of interface management, which is considered crucial for enhancing its application [4]. According to [1], there is a positive correlation between the enhanced construction project outcome and the improved interface risk management performance.

2.3. Research Objective

The study objective was to carry out literature review on interfaces in construction, interface risks and interface risks management. The study will mainly focus on these three objectives namely:

1. consequences of poor and ineffective interface risks management approach and how they influence construction project delivery
2. interface risks management methods by organisations
3. causes of interface risks and extent of influence

To support the objectives of the study, these five research questions were asked.

4. How often do you encounter interface risks between project stakeholders in a project?
5. What is the work culture related to interface risks?
6. What are the consequences of poor and ineffective interface risks management approach?
7. What are the interface risks management approaches by organisations?
8. What are the causes of interface risks?

The study focuses on a systematic approach in identifying and managing risks associated with every interface in construction projects in every phase. Literature review was done to identify critical areas of knowledge of the field of study, with the purpose of presenting a summary of recent literature on the topic. The primary objective of the study is to develop a framework on how to identify and manage interface risks in construction for overall project success.

3. Research Methodology

The primary data will be collected from project managers, civil/structural engineers, mechanical engineers, risk managers, architects, quantity surveyors, electrical engineers, construction managers, HSE managers, estate managers and other construction industry professionals actively working in construction projects in Gauteng province, South Africa through an online questionnaire developed specifically for this study to answer the research questions and to realise the research objectives. Secondary data will be collected through a review of the relevant literature, articles and journals in the construction industry. 205 research questionnaires will be distributed to participants active in the construction industry. These three Likert-type scale response anchors were chosen for the questionnaire in order to find out the level of agreement with the individual statements in the questionnaire, the frequencies of each statement or items in the questionnaire and the extent scale was used to find out the extent in which each statement or item in the questionnaire influences construction projects.The data collection process will commence by administering a biographical questionnaire to ascertain the appropriate research participants in section A. Section B (specifically B2, B3, and B4) encompasses the questions related to interface risks in construction projects. The data obtained from the questionnaire was coded, recorded, and analysed utilising the Statistical Package for the Social Sciences (SPSS). Factor analysis was conducted in order to identify the latent dimensions underlying the measured variables, as these variables are expected to exhibit correlations or anticipated correlations. This study aims to assess the impact of measured variables and examine the interrelationships among a predetermined set of defined, observed, and quantifiable constructs. According to the guidelines provided in the SPSS manual, the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett's Test of Sphericity are employed to assess the suitability of the correlation matrix as an identity matrix, thereby determining the appropriateness of the factor model.

4. Findings and Analysis

The study employed the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test to assess the interrelationships among variables, thereby informing the decision to proceed with the factor analysis of the collected data. A comprehensive set of 205 responses was obtained from the designated target population, which primarily comprises individuals within the construction industry as described in the context of questionnaire design and target group identification. Table 1 below shows the summary of the biographical data of the respondents who participated in the online survey.

Table 1. Survey participants professions in the South African construction industry.

Profession	Frequency	Percent	Valid Percent	Cumulative Percent
Quantity surveyor	16	7,8	7,8	7,8
Architect	9	4,4	4,4	12,2
Civil engineer/structural engineer	27	13,2	13,2	25,4
Builder	7	3,4	3,4	28,8
Construction manager	25	12,2	12,2	41,0
Electrical engineer	22	10,7	10,7	51,7
Mechanical engineer	20	9,8	9,8	61,5
Estate manager	8	3,9	3,9	65,4
Project manager	18	8,8	8,8	74,1
Construction engineer	13	6,3	6,3	80,5
Project engineer	8	3,9	3,9	84,4
Project administrator	9	4,4	4,4	88,8
Safety officer/engineer/manager	10	4,9	4,9	93,7
Risk manger	10	4,9	4,9	98,5
Other construction professionals	3	1,5	1,5	100,0
Total	205	100,0	100,0	

From Table 1 above, out of the 205 responses from the online questionnaire, 16 respondents were quantity surveyors, 9 were architects, 7 were builders, 8 were project engineers, 9 were project administrators, 10 were safety officers/engineers/managers, 10 were risk managers, 20 were mechanical engineers, 13 were construction engineers, 18 were project managers, 8 were estate managers, 22 were electrical engineers, 25 were construction managers, 27 were civil/structural engineers and 3 respondents were other construction professionals. Table 2 below shows age distribution of participants.

Table 2. Age distribution of respondents.

Age group	Frequency	Percent	Valid Percent	Cumulative Percent
21-25 years	4	2,0	2,0	2,0

26-30 years	16	7,8	7,8	9,8
31-35 years	32	15,6	15,6	25,4
36 -40 years	42	20,5	20,5	45,9
41-45 years	53	25,9	25,9	71,7
46 years and above	58	28,3	28,3	100,0
Total	205	100,0	100,0	

From the Table 2 above, out of the 205 respondents, 4 respondents were in the age group of 21 – 25 years, 16 were in the age group of 26 - 30 years, 32 were in the age group of 31 - 35 years, 42 were in the age group of 36 - 40 years, 53 were in the age group of 41 – 45 years, 46 respondents were in the age group of 46 years and above.The Table 3 below shows the academic qualifications of the respondents.

Table 3. academic qualifications of the respondents.

Highest Academic Qualification	Frequency	Percent	Valid Percent	Cumulative Percent
Post Matric Certificate or Diploma	11	5,4	5,4	5,4
Bachelor's degree	55	26,8	26,8	32,2
Honours Degree	28	13,7	13,7	45,9
Master's degree	70	34,1	34,1	80,0
Doctorate Degree	41	20,0	20,0	100,0
Total	205	100,0	100,0	

From Table 3 above, 11 respondents out of the 205 respondents which represented 5.4% of the respondents have post matric or diplomas as their highest academic qualifications, 55 (26.8%) had bachelor's degrees, 28 (13.7%) have honours degrees, 70 (34.1%) have master's degrees while 41 respondents which represented 20.0% of the total respondents have doctoral degrees. Table 4 below shows the organizational size of the respondents.

Table 4. Size of organizations of respondents.

Organisational Size	Frequency	Percent	Valid Percent	Cumulative Percent
Small (1 – 100 staff)	72	35,1	35,1	35,1
Medium (101 – 500)	74	36,1	36,1	71,2
Large (501 – 5000+)	59	28,8	28,8	100,0
Total	205	100,0	100,0	

From the Table 4 below, 72 respondents which represent 35.1% of the total respondents work in the small-sized industries and 74 which represent 36.1% work at medium-sized industries while 59 of the respondents which represent 28.8% work in the large-scale construction industries.

Table 5 below represents the frequency distribution for question 1 (How often do you encounter interface risks between project stakeholders in a project?)

Table 5. frequency distribution for research question 1.

How often do you encounter interface risks between project stakeholders in a project					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	11	5,4	5,4	5,4
	Sometimes	63	30,7	30,7	36,1
	Often	66	32,2	32,2	68,3
	Always	65	31,7	31,7	100,0
	Total	205	100,0	100,0	

From Table 5 above, 11 (5,4%) respondents chose rarely, 63 (30,7%) chose sometimes, 66 (32,2%) chose often and 65 (31,2%) of the total respondents chose always. Table 6 below shows the mean and standard deviation for research question 1.

 doi:10.20944/preprints202307.1821.v1

Table 6. statistics for research question 1.

How often do you encounter interface risks between project stakeholders in a project							
N							
Valid	Missing	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
205	0	3,90	4,00	4	0,913	2	5

From Table 6 above, the mean was 3,90, which was slightly below often (4) and most people answered between sometimes (3) and always (5). The median was 4,00 which means half of the respondents chose between often and always and the other half chose between often and always. The mode was 4 which means most people chose often. Table 7 below shows the responses for the research questions 2 on work cultures related to interface risks.

Table 7. responses on work culture related to interface risks.

Work culture related to interface risks		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Interface risks between project stakeholders can be classified as uncertainties	Count	1	15	39	129	21	205
	Row N %	0,5%	7,3%	19,0%	62,9%	10,2%	100,0%
Interface risks between project stakeholders can be classified as unidentified risks?	Count	1	12	57	118	17	205
	Row N %	0,5%	5,9%	27,8%	57,6%	8,3%	100,0%
Identification of hard interface risks encourages effective collaboration between project stakeholders	Count	1	2	11	119	72	205
	Row N %	0,5%	1,0%	5,4%	58,0%	35,1%	100,0%
Identification of soft interface risks encourages effective collaboration between project stakeholders	Count	0	6	27	107	65	205
	Row N %	0,0%	2,9%	13,2%	52,2%	31,7%	100,0%

Table 7 above represented the responses for questions on work culture related to interface risks. The respondents were asked to answer the questions and rank them according to their level of agreement.

For the first question (Interface risks between project stakeholders can be classified as uncertainties), 1 respondent strongly disagreed with the statement which represented 0,5% of the total responses, 15 (7,3%) respondents disagreed, 39 (19,0%) respondents were neutral, 129 (62,9%) agreed while 21 (10,2%) of the respondents strongly agreed.

For the second question (Interface risks between project stakeholders can be classified as unidentified risks?), 1 respondent strongly disagreed with the statement which represented 0,5% of the responses, 12 (5,9%) disagreed with the statement, 57 (27,8%) respondents were neutral, 118 (57,6%) agreed while 17 (8,3%) respondents strongly agreed.

For the third question (Identification of hard interface risks encourages effective collaboration between project stakeholders), 1 respondent strongly disagreed with the statement which represented 0,5% of the responses, 2 (1,0%) disagreed with the statement, 11 (5,4%) respondents were neutral, 119 (58,0%) agreed while 72 (35,1%) respondents strongly agreed.

For the fourth question (Identification of soft interface risks encourages effective collaboration between project stakeholders), no respondent strongly disagreed with the statement which represented 0,0% of the responses, 6 (2,9%) disagreed with the statement, 27 (13,2%) respondents were neutral, 107 (52,2%) agreed while 65 (31,7%) respondents strongly agreed.

Table 8 below shows the KMO and Bartlett's test for research objective 1 (consequences of poor and ineffective interface risks management approach)

Table 8. KMO and Bartlett's test for research objective 1 for B2 (consequences of poor and ineffective interface risks management approach).

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,898
Bartlett's Test of Sphericity	Approx. Chi-Square	1309,488

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 27 July 2023 doi:10.20944/preprints202307.1821.v1

	df	78
	Sig.	<0,001

From Table 8 above, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0,898 which was bigger than 0,6 which shows that factor analysis can be carried out. For the Bartlett's Test of Sphericity, the significance which is the p value was less than 0,001 which was less than 0,05 and this supports its factorability. Table 9 below shows the KMO and Bartlett's test for research objective 2 (interface risks management approaches by organisations)

Table 9. KMO and Bartlett's test for research objective 2 for B3 (interface risks management approaches by organisations).

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,915
Bartlett's Test of Sphericity	Approx. Chi-Square	4068,497
	Df	276
	Sig.	0,000

From Table 9 above, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0,915 which was bigger than 0,6 therefore, the factor analysis can be done. For the Bartlett's Test of Sphericity, the significance which is the p value is 0,000 which was less than 0,05 and this supports its factorability. Table 10 below represents KMO and Bartlett's test for research objective 3 (causes of interface risks)

Table 10. KMO and Bartlett's test for research objective 3 for B4 (causes of interface risks).

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,917
Bartlett's Test of Sphericity	Approx. Chi-Square	2767,160
	Df	171
	Sig.	0,000

From Table 10 above, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0,917 which was bigger than 0,6 which shows that the factor analysis can be done. For the Bartlett's Test of Sphericity, the significance which is the p value was 0,000 which was less than 0,05 and this supports its factorability. Table 11 below shows the responses received for research objective 1 for B2 related to consequences of a poor and ineffective interface risks management approach. The respondents were asked to rank them according to the extent scale.

Table 11. responses for the research objective 1 for B2 - the consequences of a poor and ineffective interface risks management approach.

SECTION B2		To no extent	Small extent	Moderate extent	Large extent	Very large extent	Total
Stakeholders' complaints	Count	1	5	42	101	56	205
	Row N %	0,5%	2,4%	20,5%	49,3%	27,3%	100,0%
Claims for damage	Count	0	8	40	94	63	205
	Row N %	0,0%	3,9%	19,5%	45,9%	30,7%	100,0%
Loss of profit	Count	1	2	18	87	97	205
	Row N %	0,5%	1,0%	8,8%	42,4%	47,3%	100,0%
	Count	0	8	40	89	68	205

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 27 July 2023 doi:10.20944/preprints202307.1821.v1

Reputational damage of an organisation	Row N %	0,0%	3,9%	19,5%	43,4%	33,2%	100,0%
Industrial actions	Count	0	12	60	88	45	205
	Row N %	0,0%	5,9%	29,3%	42,9%	22,0%	100,0%
Project delays	Count	2	2	22	102	77	205
	Row N %	1,0%	1,0%	10,7%	49,8%	37,6%	100,0%
Regulatory infringements	Count	2	4	77	86	36	205
	Row N %	1,0%	2,0%	37,6%	42,0%	17,6%	100,0%
Poor workflow planning and development	Count	2	4	23	113	63	205
	Row N %	1,0%	2,0%	11,2%	55,1%	30,7%	100,0%
Project overall failure	Count	2	6	24	101	72	205
	Row N %	1,0%	2,9%	11,7%	49,3%	35,1%	100,0%
Poor quality	Count	1	5	43	118	38	205
	Row N %	0,5%	2,4%	21,0%	57,6%	18,5%	100,0%
Additional costs	Count	2	1	21	102	79	205
	Row N %	1,0%	0,5%	10,2%	49,8%	38,5%	100,0%
Poor safety standards	Count	1	5	35	116	48	205
	Row N %	0,5%	2,4%	17,1%	56,6%	23,4%	100,0%
Extension of project delivery time	Count	1	5	21	109	69	205
	Row N %	0,5%	2,4%	10,2%	53,2%	33,7%	100,0%

From Table 11 above, project delays, extension of project delivery time, poor safety standards, stakeholders' complaints, project overall failure, poor workflow planning and developmentloss of profit, additional costs, reputational damage of an organisation and claims for damage were identified as the major consequences of a poor and ineffective interface risks management approach in construction projects according to the responses received.

Table 12 below shows the responses received for research objective 2 - the extent in which interface risks management approaches influence project goals and objectives and the successful execution of construction projects in South Africa. The respondents rated their answers with the extent scale.

Table 12. responses received for research objective 2 for B3 - the extent in which interface risks management approaches influence project goals and objectives and the successful execution of construction projects in South Africa.

SECTION B3		To no extent	Small extent	Moderate extent	Large extent	Very large extent	Total
Alliancing and partnering agreements	Count	0	3	23	105	74	205
	Row N %	0,0%	1,5%	11,2%	51,2%	36,1%	100,0%
Identifying third parties' dependencies to identify new interfaces	Count	0	8	46	108	43	205
	Row N %	0,0%	3,9%	22,4%	52,7%	21,0%	100,0%
Assessing third parties' dependencies to identify new interfaces	Count	0	15	41	97	52	205
	Row N %	0,0%	7,3%	20,0%	47,3%	25,4%	100,0%
Identifying third parties' dependencies to manage new interfaces	Count	1	6	56	101	41	205
	Row N %	0,5%	2,9%	27,3%	49,3%	20,0%	100,0%
Assessing third parties' dependencies to manage new interfaces	Count	0	14	44	87	60	205
	Row N %	0,0%	6,8%	21,5%	42,4%	29,3%	100,0%
Defining standard methods and procedures	Count	1	6	26	102	70	205
	Row N %	0,5%	2,9%	12,7%	49,8%	34,1%	100,0%
Establishing a Building information Modelling (BIM) volume strategy	Count	0	7	23	92	83	205
	Row N %	0,0%	3,4%	11,2%	44,9%	40,5%	100,0%
Creating a virtual construction	Count	2	9	23	104	67	205

doi:10.20944/preprints202307.1821.v1

model during the construction phase	Row N %	1,0%	4,4%	11,2%	50,7%	32,7%	100,0%
Regular meetings between project stakeholders	Count	0	8	29	98	70	205
	Row N %	0,0%	3,9%	14,1%	47,8%	34,1%	100,0%
Identification of construction supply chain risks during interfaces establishments.	Count	1	4	19	119	62	205
	Row N %	0,5%	2,0%	9,3%	58,0%	30,2%	100,0%
Identification of interface risks in the conceptualisation stage of a project	Count	0	7	22	93	83	205
	Row N %	0,0%	3,4%	10,7%	45,4%	40,5%	100,0%
Identification of interface risks in the planning stage of a project	Count	0	4	17	108	76	205
	Row N %	0,0%	2,0%	8,3%	52,7%	37,1%	100,0%
Identification of interface risks in the execution stage of a project	Count	1	4	42	89	69	205
	Row N %	0,5%	2,0%	20,5%	43,4%	33,7%	100,0%
Identification of interface risks in the interface's establishment phases	Count	0	5	24	117	59	205
	Row N %	0,0%	2,4%	11,7%	57,1%	28,8%	100,0%
Identification of interface risks in the execution stage	Count	0	7	40	88	70	205
	Row N %	0,0%	3,4%	19,5%	42,9%	34,1%	100,0%
Stakeholders' management strategies to predict how the project will affect stakeholders	Count	0	8	30	133	34	205
	Row N %	0,0%	3,9%	14,6%	64,9%	16,6%	100,0%
Stakeholders mapping to predict how stakeholders will affect the project	Count	1	10	48	93	53	205
	Row N %	0,5%	4,9%	23,4%	45,4%	25,9%	100,0%
Clash avoidance as an integral part of the construction process for interface risk management	Count	0	7	41	118	39	205
	Row N %	0,0%	3,4%	20,0%	57,6%	19,0%	100,0%
Clash avoidance as an integral part of the design process for interface risk management	Count	0	13	55	88	49	205
	Row N %	0,0%	6,3%	26,8%	42,9%	23,9%	100,0%
Clash detection as an integral part of the construction process for interface risk management	Count	0	8	47	112	38	205
	Row N %	0,0%	3,9%	22,9%	54,6%	18,5%	100,0%
Clash detection as an integral part of the design process for interface risk management	Count	0	9	47	98	51	205
	Row N %	0,0%	4,4%	22,9%	47,8%	24,9%	100,0%
Conflicts resolution carried out by parties involved	Count	0	4	22	112	67	205
	Row N %	0,0%	2,0%	10,7%	54,6%	32,7%	100,0%
Collaboration between project stakeholders	Count	1	4	19	82	99	205
	Row N %	0,5%	2,0%	9,3%	40,0%	48,3%	100,0%
Interface risks management by all the parties involved	Count	0	4	15	102	84	205
	Row N %	0,0%	2,0%	7,3%	49,8%	41,0%	100,0%

From Table 12 above, alliancing and partnering agreements, identification of construction supply chain risks during interfaces establishments, conflicts resolution carried out by parties involved, clash detection as an integral part of the construction process for interface risk management, interface risks management by all the parties involved, clash detection as an integral part of the design process for interface risk management, assessing third parties' dependencies to identify new interfaces, identification of interface risks in the conceptualisation stage of a project, identification of interface risks in the interface's establishment phases, identification of interface risks in the execution stage, defining standard methods and procedures, establishing a building information modelling (BIM) volume strategy and creating a virtual construction model during the construction phase were identified as the major interface risks management approaches that have most impacts on project goals and objectives and the successful execution of construction projects in South Africa. Table 13 below shows the responses received to what extent are the following the causes of interface risks on construction projects.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 27 July 2023 doi:10.20944/preprints202307.1821.v1

Table 13. responses to research objective 3 for B4 (what extent are the following the causes of interface risks on construction projects).

SECTION B4		To no extent	Small extent	Moderate extent	Large extent	Very large extent	Total
Poor workflow planning and development	Count	1	3	11	110	80	205
	Row N %	0,5%	1,5%	5,4%	53,7%	39,0%	100,0%
Subcontractors' negative attitudes towards teamwork	Count	1	3	39	114	48	205
	Row N %	0,5%	1,5%	19,0%	55,6%	23,4%	100,0%
Procurement delays	Count	1	4	40	104	56	205
	Row N %	0,5%	2,0%	19,5%	50,7%	27,3%	100,0%
Unpredictable and low delivery reliability	Count	1	6	37	115	46	205
	Row N %	0,5%	2,9%	18,0%	56,1%	22,4%	100,0%
Poor inventories	Count	1	8	37	102	57	205
	Row N %	0,5%	3,9%	18,0%	49,8%	27,8%	100,0%
Lack of knowledge sharing	Count	0	5	22	95	83	205
	Row N %	0,0%	2,4%	10,7%	46,3%	40,5%	100,0%
Poor understanding of the construction project process among project stakeholders	Count	1	5	17	106	76	205
	Row N %	0,5%	2,4%	8,3%	51,7%	37,1%	100,0%
Not updating changes in site layout with stakeholders	Count	1	5	37	109	53	205
	Row N %	0,5%	2,4%	18,0%	53,2%	25,9%	100,0%
Ineffective communication in site layout changes with stakeholders	Count	1	3	19	82	100	205
	Row N %	0,5%	1,5%	9,3%	40,0%	48,8%	100,0%
Disorganized construction supply chain management	Count	1	4	17	105	78	205
	Row N %	0,5%	2,0%	8,3%	51,2%	38,0%	100,0%
Neglecting the handover process between two activities involving different trades in the planning stage	Count	0	7	46	105	47	205
	Row N %	0,0%	3,4%	22,4%	51,2%	22,9%	100,0%
Excluding subcontractors during the planning stage of a project	Count	4	5	52	106	38	205
	Row N %	2,0%	2,4%	25,4%	51,7%	18,5%	100,0%
Clients' negative attitudes toward project stakeholders	Count	3	4	36	101	61	205
	Row N %	1,5%	2,0%	17,6%	49,3%	29,8%	100,0%
Incompetency	Count	0	3	22	101	79	205
	Row N %	0,0%	1,5%	10,7%	49,3%	38,5%	100,0%
Absence of contractors in project coordination meetings	Count	1	7	33	108	56	205
	Row N %	0,5%	3,4%	16,1%	52,7%	27,3%	100,0%
Absence of subcontractors in project coordination meetings	Count	0	7	39	118	41	205
	Row N %	0,0%	3,4%	19,0%	57,6%	20,0%	100,0%
Absence of suppliers and vendors in project coordination meetings	Count	2	18	73	72	40	205
	Row N %	1,0%	8,8%	35,6%	35,1%	19,5%	100,0%
Absence of vendors in project coordination meetings	Count	3	25	69	84	24	205
	Row N %	1,5%	12,2%	33,7%	41,0%	11,7%	100,0%
Contractors' negative attitudes toward project stakeholders	Count	0	8	39	112	46	205
	Row N %	0,0%	3,9%	19,0%	54,6%	22,4%	100,0%

From Table 13 above, the responses indicated that disorganized construction supply chain management, incompetency, poor workflow planning and development, subcontractors' negative attitudes towards teamwork, unpredictable and low delivery reliability, poor inventories, lack of knowledge sharing, procurement delays, ineffective communication in site layout changes with stakeholders, poor understanding of the construction project process among project stakeholders, not

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 27 July 2023 doi:10.20944/preprints202307.1821.v1

updating changes in site layout with stakeholders and disorganized construction supply chain management were identified as the major causes of interface risks in construction projects..

4.1. Exploratory Factor Analysis

Since the sample size was 205, this was done to reduce the data or summarise using a smaller set of factors or components. This was achieved by looking for groups among the intercorrelations of a set of variables. By using factor analytic techniques, data was refined and reduced to form a smaller number of related variables to a more manageable number before using them in other analysis. Factorability of the correlation matrix: to be considered suitable for factor analysis, the correlation matrix should show at least have some correlations of r = 0,3 or greater. Barlett's test of sphericity should be statistically significant at p<0,05 and the Kaiser-Meyer-Olkin values should be 0,6 or above. These values are presented as part of the output from factor analysis. Table 14 below depicts the exploratory factor analysis for research objective 1.

Table 14. Exploratory factor analysis for research objective 1 (consequences of poor and ineffective interface risks management approach).

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6,206	47,742	47,742	5,732	44,093	44,093	3,373	25,946	25,946
2	1,438	11,063	**58,805**	0,973	7,483	51,576	3,332	25,630	**51,576**
3	0,917	7,053	65,858						
4	0,715	5,498	71,355						
5	0,593	4,559	75,914						
6	0,536	4,120	80,034						
7	0,503	3,868	83,903						
8	0,454	3,493	87,395						
9	0,422	3,246	90,641						
10	0,402	3,091	93,732						
11	0,336	2,587	96,318						
12	0,253	1,943	98,261						
13	0,226	1,739	100,000						

From Table 14 above, the consequences of poor and ineffective interface risks management approach were loaded on two factors with eigenvalues of 6,206 and 1,438. These two factors explained 58,805% of the variance before rotation and 51,576% of the variance after rotation and the represent major and minor consequences of poor and ineffective interface risks management approaches. Table 15 below represents the exploratory factor analysis for research objective 2 (What are the interface risks management approaches by organisations)

Table 15. exploratory factor analysis for research objective 2 (interface risks management approaches by organisations).

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11,460	47,748	47,748	11,120	46,333	46,333	6,373	26,553	26,553
2	2,787	11,613	59,361	2,456	10,235	56,569	4,029	16,786	43,339
3	1,581	6,589	65,950	1,272	5,298	61,867	3,740	15,582	58,922
4	1,209	5,037	**70,987**	0,844	3,517	65,383	1,551	6,462	**65,383**
5	0,947	3,944	74,931						
6	0,741	3,089	78,021						
7	0,590	2,459	80,479						
8	0,522	2,174	82,653						
9	0,494	2,057	84,710						
10	0,479	1,994	86,704						

11	0,445	1,856	88,560
12	0,376	1,568	90,128
13	0,318	1,325	91,452
14	0,290	1,210	92,662
15	0,258	1,075	93,738
16	0,233	0,970	94,708
17	0,210	0,877	95,585
18	0,200	0,835	96,420
19	0,188	0,785	97,204
20	0,170	0,707	97,911
21	0,151	0,631	98,542
22	0,141	0,587	99,129
23	0,122	0,509	99,637
24	0,087	0,363	100,000

From Table 15 above, Interface risks management approaches by organisations were loaded on four factors with eigenvalues of 11,460, 2,787, 1,581 and 1,209. These four factors explained 70,987% of the variance before rotation and 65,383% of the variance after rotation. Table 16 below represents the exploratory factor analysis for research objective 3 (causes of interface risks).

Table 16. below represents the exploratory factor analysis for research objective 3 (causes of interface risks).

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9,587	50,460	50,460	9,204	48,443	48,443	4,820	25,367	25,367
2	1,960	10,317	60,776	1,568	8,251	56,694	4,007	21,089	46,456
3	1,194	6,285	67,061	0,821	4,320	61,014	2,766	14,558	**61,014**
4	0,856	4,507	71,569						
5	0,697	3,669	75,237						
6	0,640	3,370	78,607						
7	0,561	2,954	81,561						
8	0,470	2,476	84,036						
9	0,429	2,255	86,292						
10	0,388	2,041	88,332						
11	0,353	1,856	90,188						
12	0,331	1,740	91,928						
13	0,323	1,701	93,629						
14	0,272	1,433	95,062						
15	0,235	1,235	96,297						
16	0,225	1,185	97,482						
17	0,190	1,000	98,481						
18	0,168	0,883	99,364						
19	0,121	0,636	100,000						

From Table 16 above, causes of interface risks were loaded on three factors with eigenvalues of 9,587, 1,960 and 1,194. These three factors explained 67,061% of the variance before rotation and 61,014% of the variance after rotation.

4.2. Reliability Statistics of Data Collected

In order to establish the consistency of data, the value of the Cronbach's Alpha (coefficient alpha was determined). Table 17 below shows the reliability statistics for research objective 1, Cronbach's alpha coefficients must be greater than 0,7 to confirm reliability and internal consistency.

Table 17. reliability statistics for research objective 1 – B2 (consequences of poor and ineffective interface risks management approach).

Reliability Statistics	
Cronbach's Alpha	N of Items

0,907	13

From the above Table 17, the Cronbach Alpha was 0,907 which was above 0,7 therefore it was reliable. Table 18 below shows the item-total statistics for research objective 1

Table 18. item-total statistics for research objective 1.

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
B2.1	48,80	41,932	0,544	0,904
B2.2	48,78	41,420	0,577	0,902
B2.3	48,46	41,916	0,606	0,901
B2.4	48,75	40,433	0,666	0,898
B2.5	49,00	41,382	0,554	0,904
B2.6	48,59	41,253	0,653	0,899
B2.7	49,08	41,121	0,615	0,901
B2.8	48,68	41,178	0,656	0,899
B2.9	48,66	40,744	0,650	0,899
B2.10	48,90	41,328	0,667	0,899
B2.11	48,57	41,335	0,662	0,899
B2.12	48,81	41,420	0,645	0,900
B2.13	48,64	41,624	0,618	0,901

Table 18 above contains total statistics for all the items in B2 for research objective1.

Table 19 above shows a Cronbach alpha value of 0,952, which was above 0,7 therefore it was reliable. Table 20 below shows the item-total statistics for research objective 2.

Table 19. reliability statistics for research objective 2 - B3 (What are the interface risks management approaches by organisations).

Reliability Statistics	
Cronbach's Alpha	N of Items
0,952	24

Table 20. item-total statistics for research objective 2.

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
B3.1	93,35	152,170	0,611	0,950
B3.2	93,66	151,499	0,588	0,950
B3.3	93,66	148,607	0,658	0,950

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 27 July 2023 doi:10.20944/preprints202307.1821.v1

B3.4	93,72	151,057	0,595	0,950
B3.5	93,63	147,695	0,684	0,949
B3.6	93,43	150,207	0,643	0,950
B3.7	93,35	149,982	0,659	0,950
B3.8	93,47	150,662	0,576	0,951
B3.9	93,45	149,435	0,676	0,949
B3.10	93,41	150,881	0,682	0,949
B3.11	93,34	148,834	0,727	0,949
B3.12	93,32	151,621	0,654	0,950
B3.13	93,49	149,114	0,674	0,949
B3.14	93,45	150,327	0,719	0,949
B3.15	93,49	149,653	0,641	0,950
B3.16	93,63	151,205	0,683	0,949
B3.17	93,66	147,716	0,710	0,949
B3.18	93,65	151,062	0,651	0,950
B3.19	93,73	147,484	0,715	0,949
B3.20	93,69	150,822	0,642	0,950
B3.21	93,64	149,036	0,683	0,949
B3.22	93,39	151,896	0,630	0,950
B3.23	93,23	149,965	0,672	0,950
B3.24	93,27	152,896	0,574	0,951

Table 20 above contains total statistics for all the items in B3 for research objective 2. Table 21 below depicts the reliability statistics for research objective 3 - B4.

Table 21. reliability statistics for research objective 3 - B4 (causes of interface risks).

Reliability Statistics	
Cronbach's Alpha	N of Items
0,945	19

From Table 21 above, the Cronbach Alpha was 0,945, therefore it was reliable. Table 22 below shows the item-total statistics for research objective 3 – B4 (causes of interface risks).

Table 22. item-total statistics for research objective 3 – B4 (causes of interface risks).

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
B4.1	72,19	99,701	0,645	0,942
B4.2	72,48	100,006	0,577	0,943
B4.3	72,45	98,082	0,672	0,942
B4.4	72,51	98,683	0,646	0,942
B4.5	72,47	96,966	0,705	0,941
B4.6	72,23	99,413	0,606	0,943
B4.7	72,25	97,700	0,730	0,941
B4.8	72,46	98,583	0,644	0,942
B4.9	72,13	98,631	0,654	0,942
B4.10	72,23	98,945	0,654	0,942

B4.11	72,54	97,642	0,705	0,941
B4.12	72,65	96,659	0,712	0,941
B4.13	72,44	97,973	0,627	0,943
B4.14	72,23	100,315	0,578	0,943
B4.15	72,45	96,690	0,752	0,940
B4.16	72,54	98,505	0,687	0,942
B4.17	72,84	95,338	0,703	0,941
B4.18	72,99	95,838	0,692	0,942
B4.19	72,52	97,525	0,725	0,941

Table 22 above contains total statistics for all the items in B4 for research objective 3.

5. Results And Discussion

The respondents were asked to answer questions on work culture related to interface risks.As depicted by Table 7 above, 1 respondent strongly disagreed that interface risks between project stakeholders can be classified as uncertainties which represented 0,5% of the total responses, 15 (7,3%) respondents disagreed, 39 (19,0%) respondents were neutral, 129 (62,9%) agreed while 21 (10,2%) of the respondents strongly agreed. 1 respondent strongly disagreed that interface risks between project stakeholders can be classified as unidentified risks which represented 0,5% of the responses, 12 (5,9%) disagreed with the statement, 57 (27,8%) respondents were neutral, 118 (57,6%) agreed while 17 (8,3%) respondents strongly agreed with the statement. The responses showed that 119 (58%) respondents agreed that the identification of hard interface risks encourages effective collaboration between project stakeholders while 72 (35,1%) respondents strongly agreed. 107 (52,2%) respondents agreed that the identification of both soft interface risks encourages effective collaboration between project stakeholders while 65 (31,7%) respondents strongly agreed.

For the research objective 1, the Spearman's Rho showed that there is correlation between the consequences of poor and ineffective interface risks management approach and their influences on the project since the values of the Spearman's coefficient are bigger than 0,3 and from Table 8 above, for the Bartlett's Test of Sphericity, the significance, p value was less than 0,001 which was less than 0,05, which means the higher the probability of the consequences such as project delays, poor quality, industrial actions, additional costs etc., the higher the impacts on the project and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0,898 which was bigger than 0,6 which shows that factor analysis can be carried out.

For the research objective 2, the Spearman's Rho showed that there was correlation between the interface risks management approaches and their influences on the project goals and objectives and the successful execution of construction projects since the values of the Spearman's coefficient were bigger than 0,3 and from Table 9 above, for the Bartlett's Test of Sphericity, the significance, p value was 0,000 which was less than 0,05, which means the higher the probability of the interface risks management approaches such as defining standard methods and procedures, creating a virtual construction model during the construction phase, establishing a building information modelling (BIM) volume strategy etc , the higher the impacts on the project goals and objectives and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0,915 which was bigger than 0,6 which shows that factor analysis can be done.

For the research objective 3, the Spearman's Rho showed that there was correlation between the extent in which the following causes of interface risks on construction projects and the influences on the project since the values of the Spearman's coefficient are bigger than 0,3 and from Table 10 above, for the Bartlett's Test of Sphericity, the significance, p value was 0,000 which was less than 0,05, which means the higher the probability of the causes of interface risks such as incompetency, poor inventories, lack of knowledge sharing, procurement delays etc., the higher the impacts on the project execution and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0,917 which was bigger than 0,6 which shows that factor analysis can be carried out.

6. Conclusions

Interface risk is one of the major challenges facing the construction industry because construction projects are complex by nature involving a lot of activities and participants with different responsibilities and tasks. It is crucial to carefully identify and manage these risks arising from the interfaces since they are inherent in all the construction project phases according to the findings of the survey. The study indicated that most construction projects encounter interface risks throughout the project life cycle and if they are not carefully and properly identified and managed in the project, they have negative influences on project objectives and can evidently lead to project failure or abandonment. Interface risks must be continually identified and managed during the conceptualisation, planning, interface establishment phases and carefully assessed, monitored and managed throughout the project. Effective communication, knowledge and information sharing among project stakeholders have positive impacts on the success of the project as well as identifying both soft and hard interface risks as this will encourage effective collaboration, alliancing and partnering agreements between project stakeholders, mitigate conflicts and clashes among stakeholders. Effective interface risks management in construction projects will minimise and save cost and time, mitigate industrial, actions, claims for damage, improve and maintain project quality and safety, protect the environment, facilitate good workflow planning and development, protect the reputation of the organisation that would have been damaged as a result of regulatory infringements, industrial actions, claims for damages, extended projected delivery time, stakeholders complaints, project abandonment and failure. Identifying and assessing parties' dependencies to identify and manage new interfaces is important for project success. For effective interface risks management, standard methods and procedures must be defined, building information modelling volume strategy must be established and virtual construction model must be created. Regular meeting with stakeholders facilitates effective interface risks management. Stakeholders attitude towards project coordination is vital to project success. Clash detection and avoidance must be integrated in the planning, design and construction stages and conflicts must be resolved by every party involved. Effective construction supply chain management is important in project delivery and procurement deliveries must be timely, predictable and reliable and inventories must be updated regularly for effective project site coordination and workflow. Incompetent labour force, poor understanding of construction project processes, contractors, clients and subcontractors' negative attitudes generate a lot of interface risks and these must be carefully identified and managed during the planning and contracting stages of the projects. Changes in site layouts must be updated and communicated among project participants. To save time, minimise cost, maintain anticipated project quality, safety and standards, interface risks must be carefully identified and managed by project participants and every stakeholder must participate in project coordination meetings and comply with the project guidelines and actively participate in identifying and managing interface risks throughout the project for the successful execution of the project.

Author Contributions: Conceptualization, M.O., A.V. and JH.C.P.; Investigation, M.O.; Methodology, M.O.; Supervision, A.V. and JH.C.P; Writing – original draft, M.O.; Writing – review & editing, A.V. and JH.C.P.

Funding: This research is funded by the university of Johannesburg, South Africa.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Shen, W., Tang, W., Wang, Y., Duffield, C. F., Hui, F. K. P. & Zhang, L. (2021). Managing Interfaces in Large-Scale Projects: The Roles of Formal Governance and Partnering. Journal of Construction Engineering and Management, 147 (7), 04021064. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002101
2. Paik, S. M., Leviakangas, P., & Choi, J. (2022). Making most of BIM in design: Analysis of the importance of design coordination. *International Journal of Construction Management*, *22*(12), 2225-2233.
3. Sami Ur Rehman, M., Thaheem, M. J., Nasir, A. R., & Khan, K. I. A. (2022). Project schedule risk management through building information modelling. *International Journal of Construction Management*, *22*(8), 1489-1499.
4. Shen, W., Choi, B., Lee, S., Tang, W., & Haas, C. T. (2018). How to improve interface management behaviors in EPC projects: Roles of formal practices and social norms. *Journal of Management in Engineering*, *34*(6), 04018032
5. Gusakova, E. (2018). Organizational and technological genesis as a tool for strategic planning of large-scale real estate development projects. In *MATEC Web of Conferences* (Vol. 170, p. 01015). EDP Sciences.
6. Malla, V., & Delhi, V. S. K. (2022). Determining interconnectedness of barriers to interface management in large construction projects. *Construction Economics and Building*, *22*(2), 69-101.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 27 July 2023 doi:10.20944/preprints202307.1821.v1

7. Pavlov, A. S., Ginzburg, A. V., Gusakova, E. A., & Kagan, P. B. (2019). Management of large-scale projects for the construction of industrial facilities. *Monograph. Ministry of Science and Higher Education of the Russian Federation, National Research Moscow State University of Civil Engineering. Publishing house MISI-MGSU, Moscow*.
8. Ding, Z., Liu, S., Liao, L., & Zhang, L. (2019). A digital construction framework integrating building information modeling and reverse engineering technologies for renovation projects. *Automation in Construction*, *102*, 45-58.
9. Hazır, Ö., & Ulusoy, G. (2020). A classification and review of approaches and methods for modeling uncertainty in projects. *International Journal of Production Economics*, *223*, 107522.
10. Zhao, S., Wang, J., Ye, M., Huang, Q., & Si, X. (2022). An evaluation of supply chain performance of China's prefabricated building from the perspective of sustainability. *Sustainability*, *14*(3), 1299.
11. Ahn, S., Shokri, S., Lee, S., Haas, C. T., & Haas, R. C. (2017). Exploratory study on the effectiveness of interface-management practices in dealing with project complexity in large-scale engineering and construction projects. *Journal of Management in Engineering*, *33*(2), 04016039.
12. Mhlanga, N., & BABATUNDE, D. O. K. (2018). *Improving Interface Management on a Mega Construction Project* (Doctoral dissertation, University of the Witwatersrand, Faculty of Engineering and the Built Environment).
13. Li, Y., He, N., Li, H., Liu, Z., & Qi, J. (2021). Influencing factors on inter-organizational trust asymmetry behavior in construction projects: Evidence from China. *Engineering, Construction and Architectural Management*, *28*(1), 308-331.
14. van Hoeij, K. (2022). Professionalising interface management in the Dutch construction industry: From a variety of perspectives towards shared principles.
15. Araújo, A.G., Carneiro, A.M.P. and Palha, R.P., 2020. Sustainable construction management: A systematic review of the literature with meta-analysis. Journal of Cleaner Production, [e-journal] 256, p.120350. https://doi.org/10.1016/j. jclepro.2020.120350
16. Malla, V., & Delhi, V. S. K. (2022). Determining interconnectedness of barriers to interface management in large construction projects. *Construction Economics and Building*, *22*(2), 69-101.
17. Leu, S. S., Yang, C. Y., & Hsu, Y. J. (2021). A Novel Development of TRIZ-Analogic Construction Interface Problem Identification and Solutions Framework. *Advances in Civil Engineering*, *2021*, 1-17.
18. Shen, W., Tang, W., Wang, S., Duffield, C. F., Hui, F. K. P., & You, R. (2017). Enhancing trust-based interface management in international engineering-procurement-construction projects. *Journal of Construction Engineering and Management*, *143*(9), 04017061.
19. de Ruiter, N. (2023). Interface Management advancement using Risk Assessments.
20. Bommasani, R., Hudson, D. A., Adeli, E., Altman, R., Arora, S., von Arx, S., ... & Liang, P. (2021). On the opportunities and risks of foundation models. *arXiv preprint arXiv:2108.07258*.
21. Silva, N., & Pålsson, H. (2022). Industrial packaging and its impact on sustainability and circular economy: A systematic literature review. *Journal of Cleaner Production*, *333*, 130165.