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EXPLORING SOCIAL CONFLICT SPREAD PATTERNS FOR PUBLIC RAILWAY PROJECTS USING LARGE LANGUGE MODEL

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Abstract

Social conflicts in public construction projects have become increasingly complex due to growing involvement of diverse stakeholder and broader societal attention. These conflicts can escalate from regional and spread to national level unless they are unmanaged and can be significant risk to project success. With advancements in Natural Language Processing, previously hard-to-obtain data can now be efficiently processed, offering new opportunities for conflict analysis in the construction field. This study aims to identify social conflict diffusion patterns in public construction through news article analysis. Two similar public urban railway projects in South Korea were selected for comparative case analysis. The authors employ 3-phase news article data processing: (1) web crawling of regional and national news articles, (2) duplicate removal and keyword filtering, and (3) classification using GPT-4o model based on 16 conflict drivers identified from literature review. The findings revealed the importance of early conflict detection and proactive governance in mitigating social conflicts in infrastructure projects. This study demonstrates the potential usage of NLP techniques in systematically analysing large-scale textual data to identify patterns in conflict emergence, escalation and decrement. By identifying key conflict drivers and their diffusion patterns, the findings provide valuable insights for proactive conflict management, emphasizing the importance of early intervention and transparent communication to prevent regional issues from spread into broader societal challenges.

Keywords: conflict management, natural language processing, social conflict diffusion, public construction project.

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1. Introduction

In recent years, public construction projects have become more complex due to the growing involvement of various participants and the diversity of their interests. As a result, conflicts among stakeholders have become more frequent and complex. These conflicts can lead to increased project cost, delays, and even termination of projects [1]. Therefore, systematic conflict management is essential to ensuring the success of public construction projects. Conflicts in public construction projects are often intensified by external stakeholders who are not directly involved in the project, including residents, governments, environmental organizations [2]. In severe cases, such conflicts can evolve and spread from a regional context to national level disputes.

The development of social media has made it easier for individuals to share and disseminate information. Not just providing information, social media enables large-scale interpersonal communication by allowing people to express opinions and engage in public discourse [3]. Among various social media, news data provides rich information that enables to obtain generalizability and broad perspectives of social phenomena [4]. Although a vast number of news articles related to construction projects are available, it is challenging to process and utilize all data with human power. To address this limitation, this study utilizes Natural Language Processing (NLP) techniques to analyse how conflict evolve and spread over time. NLP has emerged as a powerful tool for extracting patterns, keywords, and automatically classifying large-scale textual data [5]. The integration of NLP with news articles presents a novel approach to identifying conflict drivers which can evolve and spread over time.

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Although unmanaged conflicts can cause widespread social impacts, academic research has not yet been widely conducted. While various studies have examined conflict management in construction, most have focused on internal stakeholders such as contractor, owner, financial organizations, claim advisors [6, 7]. There is a lack of research of external stakeholders of construction especially how conflicts evolve and spread. Therefore, this study aims to empirically analyse the drivers that contribute to evolve and spread of conflicts involving both internal and external stakeholders through a comparative analysis of two construction projects using news articles and NLP technique.

2. Literature review

2.1. Diffusion theory of social conflict

Social conflict is a dynamic phenomenon that spreads through various social conditions and interactions among individuals. Early social theorists suggested that the diffusion of behaviour occurs through imitation. Tarde [8] explained that individuals adopt behaviours by observing and mimicking others. Le Bon [9] argued that individuals tend to follow behaviours of the crowd to which they belong. These theories help explain how social behaviours, including conflict can spread rapidly both within and beyond groups. In the early 21st century, Myers [10] discuss about spread pattern of social incidents such as riots. He also emphasized that mass media plays a crucial role in transmitting information and sharing emotions among people. In summary, social behaviours including conflict can emerge across various domains, and mass media can act as a powerful accelerator of their diffusion.

Rogers et al. [11] proposed theory of diffusion of innovations, which explains how new ideas, behaviours, and technologies spread within a society. The development of social media such as social networking service, news, online community has further accelerated spreading of innovation. In the era of big data, the diffusion of innovations occurs more rapidly than ever before. As a result, negative social behaviours can spread quickly, making proactive management and early intervention is crucial [12]. Conflicts occurred in the construction field similarly tend to evolve and spread due to conflicts of interest among complex stakeholders as part of social behaviour. However, previous studies have rarely studied on the diffusion patterns of conflict within the construction field. Therefore, this study aims to identify diffusion patterns in the construction sector and provide practical implications for effective conflict management.

2.2. Conflict management in the construction field

Public construction projects not only generate economic value but also provide essential infrastructure for citizens. As citizen demand and capital inflows increase, large scale public projects are becoming more common [2]. These public projects involve numerous stakeholders [6, 7], and unmanaged conflicts among them can lead to escalate into serious social conflicts [13]. Accordingly, many previous studies have examined conflict management in the construction field. Jaffar et al. [1] categorized conflict drivers into three domains based on literature review. They found behavioural, contractual, and technical problems can cause conflicts. Brockman [14] conducted surveys with actual construction workers to analyse the cost, cause, and consequence of construction conflicts. Park et al. [15] analysed conflict drivers using real project data and proposed five key strategies to manage critical conflicts. More recently, Shojaat et al. [16] applied network analysis to identify major conflict drivers, while Zeberga et al. [17] proposed a framework for applying AI technology to contractual conflict management. While these studies have contributed significantly to understanding and managing construction conflicts, they primarily focused on internal project stakeholders directly involved in the projects.

However, as projects complexity increases, external stakeholders have gained greater attention [18]. Lee et al. [2] developed social conflict management framework based on 22 Korean public mega projects. They identified five conflict scenarios with specific conflict events and drivers. It has meaning that they presented the root causes and transmission path of conflicts. Min et al. [19] focused on the physical characteristics of public construction projects, categorizing them into network and cluster types. While previous studies have primarily focused on conceptual frameworks, their study tried to find conflict occurrence in a sequential manner. As a result, they created a paradigm model based on the order of conflict occurrence. Following this, Baek et al. [4] utilized NLP technique on news articles to extract and

classify conflict drivers. This approach enables proactive management of social conflicts in a quantitative manner.

In summary, conflict research in the construction field has evolved through various perspectives, offering valuable insights and practical directions for conflict management in both industry and academia. However, a key research gap remains in understanding how construction conflicts evolve and spread into broader societal issues. This study addressed this gap by analysing conflict diffusion patterns from regional to national level.

2.3. Data-Driven research in construction

Using social media not only provides information but also generates and shares opinions [3]. Among various media, news articles provide diverse information, enabling to obtain generalizability and broad perspectives of social phenomena [4]. People can easily search for news with desired keywords and obtain vast amount of information. However, previous studies in the construction field have faced limitations in utilizing large scale data due to difficulties in securing project-specific data. In this context, development of NLP and text mining technologies has enabled efficient processing of large-scale news data in the construction field [5].

Growing application of NLP technology in the construction field, research is being conducted in new eras such as sentimental analysis, complaint analysis, and news crawling [4, 5, 20]. ChatGPT based on Large Language Models (LLM) serves as a powerful tool for extracting and classifying information based on user-defined prompt. LLM is trained on massive datasets and can understand context, implicit meaning, and generate human-like text. Compared to other models, ChatGPT shows superior performance across various domains [5, 21]. In the field of construction conflict analysis, ChatGPT enables the automated processing of large-scale public data such as news articles. These characteristics offer a new paradigm for proactive conflict management through quantitative data analysis.

In this study, the authors select two similar public railway projects to compare and analyse conflict diffusion from regional to national level. News articles were collected sequentially using web crawling. Regional news was limited to representative media in the region where the project was conducted, and national level news is acquired from comprehensive media through Korea's largest portal site Naver [22]. The collected news data was processed using LLM, and the analysis results of the two projects were compared to identify conflict spread patterns. Based on the above discussion, this study focuses on how regional conflicts evolve and spread into national level. Furthermore, it aims to identify the diffusion patterns of social conflicts by analysing news media through LLM technology. To achieve this, the following two research questions are proposed.

Research Question 1: Which conflict drivers can cause regional conflicts to spread to national level?

Research Question 2: What are the differences in the conflict diffusion patterns between two similar public projects?

3. Methodology

3.1. Case selection

To examine the diffusion of social conflicts in the construction field, this study selected two projects in South Korea based on the following criteria. (1) Project Similarity: This study chose two public urban railway developments initiated as public-private partnership (PPP) projects. Due to the heterogeneous nature of construction projects, risks and conflicts that may arise in each project are different. Therefore, selecting similar projects enables a more controlled comparisons, focusing on conflict diffusion rather than fundamental project differences. (2) Contrasting Diffusion Outcome: A key focus of this study is whether regional conflicts evolve and spread to the national level. Based on preliminary research and media analysis, one project was identified as having experienced significant conflict diffusion, while the other remained localized. Based on these criteria, two representative cases, Busan-Gimhae Light Rail

Transit (BGLRT) and Daegu Urban Railway Line 3 were selected. Characteristics of two projects are summarized in Table 1.

Table 1. Overview of selected public urban railway projects

Case	Project title	Region	Completion year	Conflict diffusion
A	Busan-Gimhae Light Rail Transit	Busan – Gimhae	2011	Spread to national level
B	Daegu Urban Railway Line 3	Daegu	2015	Remained localized

3.2. Data collection

Using a range of secondary data for case selection, the authors established a foundational understanding of each project. This study referred to various documents including feasibility studies, audit reports, post-evaluation reports, and research papers. These documents provided information on project background, stakeholders, governance structure, and outcome. However, data published by public institutions may show weak view of certain perspectives [2], they were insufficient to fully contain conflicts pattern or outcomes. To address this, this study applied 3-phase news article data processing shown in Fig. 1.

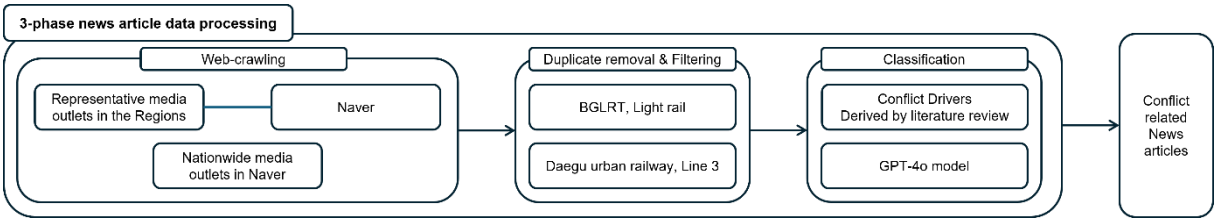

Fig. 1. Framework of 3-phase news article data processing

First, relevant news articles were collected via web crawling from both regional media and nationwide sources on Naver [22]. Second, duplicate articles and irrelevant content were filtered out to ensure data reliability. Lastly, the refined articles were classified using the GPT-4o model to identify conflict-related content and categorize them by conflict drivers defined in Section 3.3. This approach enabled structured tracking of conflict diffusion over time based on large-scale unstructured text data.

This study collected news articles related to two public railway construction projects in South Korea. For case A, regional articles were crawled from 11 representative media outlets in the Busan and Gimhae areas (Appendix A), while national-level articles were collected via the Naver news platform. Similarly, for case B, regional articles were obtained from 10 major media outlets in the Daegu area (Appendix A), with national level articles also sourced from Naver. For both cases, the same 3-phase news article data processing was applied: The results of this process are summarized in Table 2.

Table 2. Number of news articles derived from 3-phase data processing

Phase	Case A		Case B	
	Regional	National	Regional	National
Phase 1 (Web crawling)	3,077	5,314	12,885	6,969
Phase 2 (Duplicate removal & filtering)	2,631	4,151	5,783	3,144
Phase 3 (Classification)	996	1,481	865	802

3.3. Conflict Drivers for News Classification

Previous studies based on case studies and literature reviews have identified various conflict drivers depending on their own research purpose. In this study, key conflict drivers from each paper categorized

into 16 drivers and shown in Table 3. This table include both Internal and external conflict drivers relevant to construction project.

Table 3. Conflict drivers of reviewed study

ID	Conflict Driver	[1]	[2]	[4]	[15]	[19]
C-1	Lack of communication		✓	✓	✓	✓
C-2	Lack of information disclosure	✓	✓	✓	✓	✓
C-3	Compensation		✓	✓	✓	✓
C-4	Government-level conflict		✓	✓	✓	
C-5	Community people objection		✓	✓	✓	
C-6	Damage to private property		✓	✓	✓	✓
C-7	Damage to historic sites		✓		✓	✓
C-8	Economic impact on region		✓	✓	✓	✓
C-9	Environmental concerns		✓	✓	✓	✓
C-10	Noise and vibration impact		✓	✓	✓	✓
C-11	Business urgency	✓			✓	✓
C-12	Location and route selection issue		✓	✓	✓	✓
C-13	Design or construction flaws		✓	✓	✓	✓
C-14	Inadequate technical applicability		✓	✓	✓	✓
C-15	Facility harmfulness				✓	✓
C-16	Shortage of finance	✓		✓		

To classify conflict-related content in news articles, the 16 conflict drivers were incorporated into a prompt used for GPT based analysis. The prompt was designed to instruct the model to analyse each article and identify whether any of the predefined conflict drivers were mentioned or implied. Specifically, the prompt asked GPT to examine the article content, detect references to the conflict drivers, and extract any identified terms. This approach enabled automated classification of unstructured textual data into structured categories, allowing for a systematic analysis of conflict diffusion patterns based on news media content. Conflict driver distribution of case A and case B obtained in this way is show in Fig. 2.

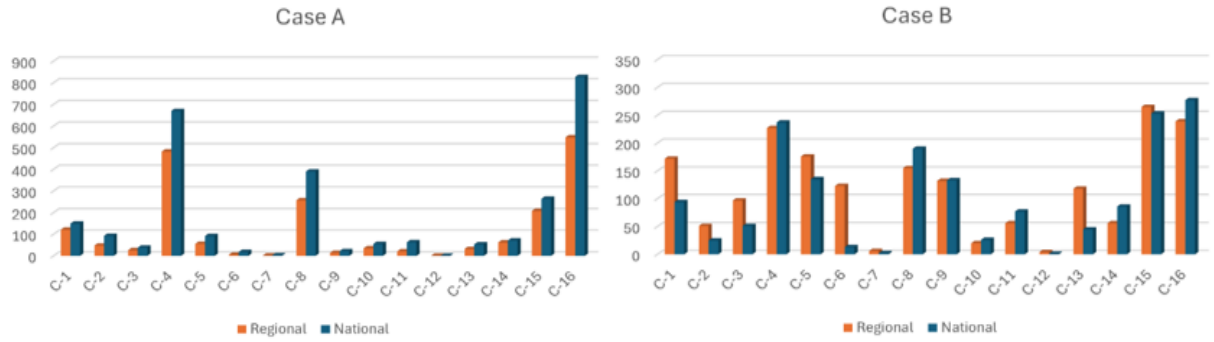

Fig. 2. Comparative distribution of conflict drivers in Case A and Case B

4. Comparative analysis of conflict diffusion in two public urban railway projects

This section presents a comparative case analysis of the conflict dynamics in two public urban railway projects in South Korea. Although both projects were implemented as public infrastructure projects under financial and structural constraints, the patterns and outcomes of social conflict diffusion exhibited notable differences.

4.1. Common structural conditions and differenct patterns

Both case A and case B faced significant financial issues during the planning and implementation phases. In case A, budget limitations led to the restructuring of the project into a Build-Transfer-Lease

(BTL) with Minimum Revenue Guarantee (MRG) support. Similarly, case B was changed from a mixed-type underground and aboveground rail system into a fully aboveground light rail system due to financial limitations. These financial challenges caused early-stage conflict drivers that were commonly observed in both regional and national media. Most frequently identified drivers were shortage of finance (C-16) and government-level conflict (C-4) shown in Fig. 2, highlighting challenges in coordination and the financial limitations of PPP projects.

As shown in Fig. 3, C-4 and C-16 demonstrate how similar structural constraints led to different media attention and conflict spread patterns across the two cases. In case A, both conflict drivers increased to national level between 2010 and 2012. This shows a failure to proactively address the issues of the MRG. Notably, national level news related to C-16 peaked nearly 180 articles in 2011, indicating increasing public concern over financial risks. Although articles related to both C-4 and C-16 declined after 2013, but they reemerged due to reflecting unresolved institutional and financial issues until the system reformed in 2017. In contrast, case B shows relatively low levels of C-4 and C-16 throughout the project timeline. This suggests that although similar financial limitations were present, proactive conflict mitigation helped solving conflicts within regional boundaries and prevent broader escalation.

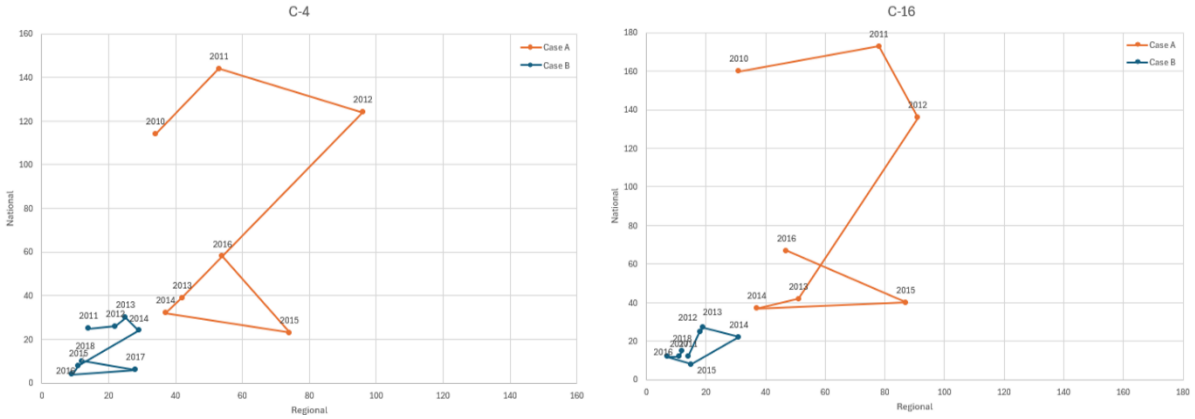

Fig. 3. Comparison of Regional-National news articles related to C-4 and C-16 of case A and B

4.2. Case A: Escalation and national conflict diffusion

Public complaints have increased since the project's construction was completed in 2011. The MRG system, initially designed to attract private investment by minimizing financial risk, resulted in severe financial burdens for the local governments due to drastically low demand. Only 20% of expected demand was utilized. The resulting compensation payouts caused prolonged conflicts between local authorities and the central government. Subsequently, new conflict drivers such as community people objection (C-5) and facility harmfulness (C-15) emerged. These compounded objections led to widespread media coverage with a noticeable transition from local to national conflict between 2011 and 2016. These characteristics can be reflected through Fig. 4, which shows the quarterly frequency of conflict related news articles for C-5 and C-15 since 2010.

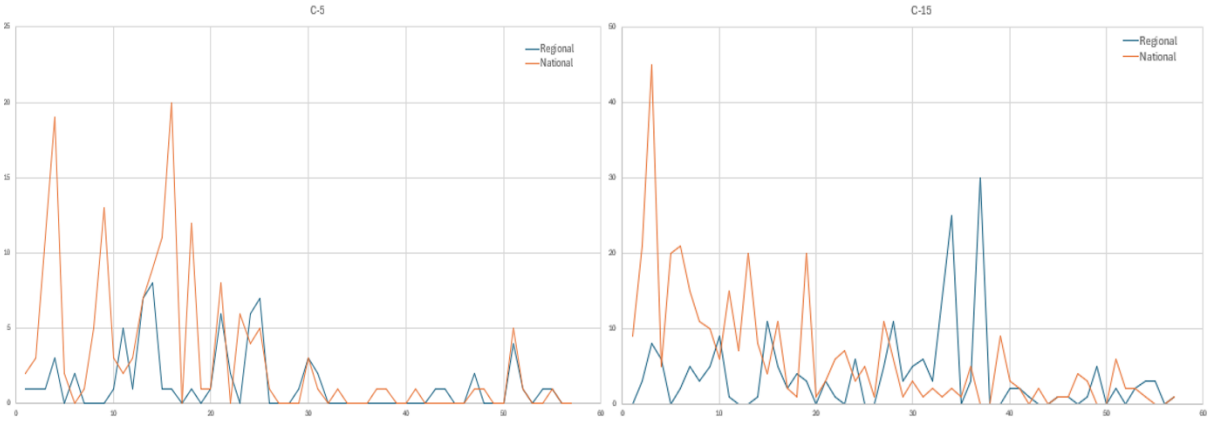

Fig. 4. Quarterly trends of C-5 and C-15 conflict coverage in case A

4.3. Case B: Quick action and limiting conflict spread

Although case B faced similar financial and design constraints, its outcome was different. The redesign into an aboveground rail system provoked concerns regarding noise pollution, privacy invasion and invasion of ecosystem. These were reflected in elevated mentions of community people objection (C-5) and environmental concerns (C-9). However, the local government's early technical responses, including eco-friendly vehicle design, noise reduction infrastructure and privacy preserving technologies such as fogging windows near residential zones were effective in conflict resolution. As a result, conflict frequencies remained localized, and national media coverage was limited. As shown in Fig. 5, conflict frequencies are lower than case A and did not spread to national level. This highlights the importance of early response in mitigating conflict during the planning and operation phase of the project.

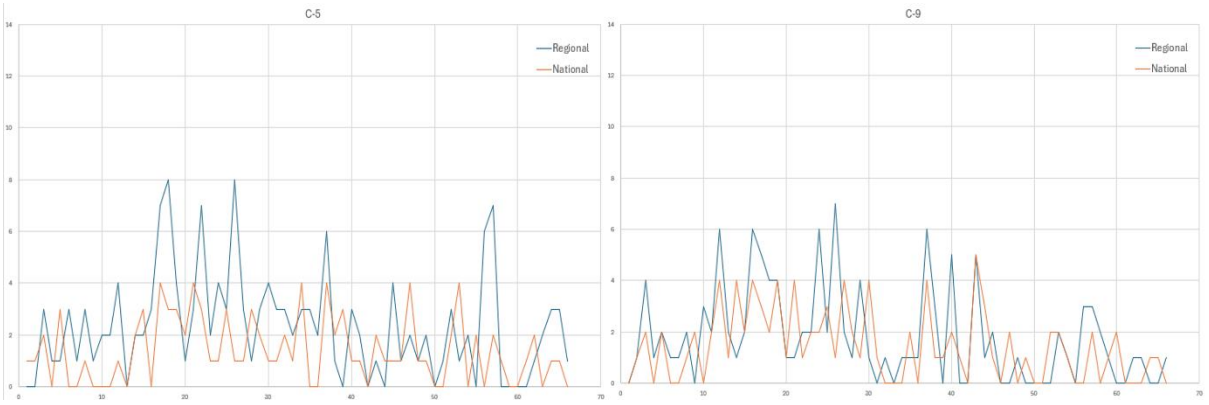

Fig. 5. Quarterly trends of C-5 and C-9 conflict coverage in case B

5. Discussion

The comparative analysis of case A and case B revealed how similar structural of projects can lead to divergent conflict diffusion patterns depending on the timing and governance response. In case A, the delayed adjustment to financial constraints and the rigid structure of the MRG led to widespread conflicts that diffused from local concerns to national level conflicts. News article analysis showed significant increases in conflict drivers such as government-level conflict (C-4) and shortage of finance (C-16) between 2010 and 2012, indicating governance failures in managing early warning signs. Moreover, as the project entered in operational phase, additional conflict drivers such as community people objection (C-5) and facility harmfulness (C-15) emerged, contributing to long-term reputational and financial impacts. In contrast, case B, despite encountering similar design compromises and local concerns demonstrated the efficiency of timely and technically proactive management. The city of Daegu's early implementation of eco-friendly vehicle, noise reduction infrastructure and privacy preserving features mitigated potential conflicts spread. It is confirmed by relatively low and regionally contained mentions of community people objection (C-5) and environmental concerns (C-9) throughout the project timeline.

These findings support the proposition that conflict diffusion is not solely determined by the structural characteristics of a project but rather by the capacity of institutions to respond proactively to emerging concerns.

6. Conclusion

This study analysed news articles using GPT to compare the diffusion of social conflict in two similar public construction projects. By selecting two public urban railway projects in South Korea and classifying conflict drivers identified in literature review, 3-phase news article data processing was applied to extract and classify conflict drivers related to each article content. The frequency of extracted conflict drivers was then compared with secondary project data to identify the timing of conflict emergence, escalation and mitigation.

The comparative findings highlight the critical role of proactive conflict management. While both projects faced similar financial and structural limitations, their conflict diffusion significantly diverged due to differences in governance response. Case A suffered prolonged national level conflicts, whereas case B effectively managed conflicts through early technical and policy measures. This highlights that there is no universal approach to conflict resolution, but rather a need to identify conflict drivers that can contribute to social conflict diffusion and to take proactive measures.

Despite these contributions, this study has several limitations. First, due to limited media digitization in the early 2000s, only news articles from the construction and operation phases were available. This constraint restricted the analysis from encompassing the full project lifecycle. Second, the use of annual and quarter frequency as the primary conflict spread offers only a comprehensive view. Future studies should employ more detailed sequential analyses and adopt advanced methodologies such as social network analysis to capture stakeholder relationships and influence dynamics. Finally, as this study focused solely on urban rail projects, future research could expand the scope to other types of public infrastructure to derive more generalizable insights on social conflict diffusion in the public construction sector.

Acknowledgements

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Appendix A. Name of representative media outlets

Table 4. represents 11 representative media outlets for Case A in Busan and Gimhae area, and 10 representative media outlets for Case B in Daegu area.

Table 4. Representative media outlets for Case A and B

Case	Region	Name of media outlets
Case A	Busan	Busan Ilbo, Gyeongnam Domin Ilbo, Gyeongnam Domin Newspaper, Gyeongnam Ilbo, Gyeongnam Newspaper, KBS Busan, KNN, MBC Gyeongnam
	Gimhae	Gimhae Ilbo, Gimhae News, Yangsan Newspaper
Case B	Daegu	Daegu Ilbo, Daegu MBC, Daegu Newspaper, Daegu the Korea Times, Gyeongbuk Daily News, Gyeongbuk Domin Ilbo, Gyeongbuk Ilbo, Gyeongbuk Maeil, Maeil Newspaper, Yeongnam Ilbo

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