京都大学	博士（　工学　）	氏名	TZIOUTZIOS Dimitrios
論文題目	Exploring Natech Risk Communication for Participatory Risk Management: Understanding citizens' communicative behaviour through a comparative study and a serious game （参加型リスク管理のための Natech リスクコミュニケーションに関する研究：比較研究とシリアスゲームを通じた市民のコミュニケーション行動の理解）		

（論文内容の要旨）

Active community engagement plays a central role in effective disaster risk reduction. Promoting transparency throughout the decision-making process and disseminating risk information via risk communication empowers all involved stakeholders to make risk-informed decisions. Current risk communication approaches emphasise trust and relationship-building among stakeholders, practices that create favourable conditions for community involvement and participatory disaster risk management. Also, recent approaches, such as serious gaming (games with purposes other than entertainment), present promising risk communication tools that can promote public awareness and support participatory decision-making for risk-related issues.

Such risk communication issues have only recently emerged considering large-scale, complex disasters, such as technological accidents triggered by natural hazards, also known as Natech. When chemical risk communication is limited, individuals might not have the necessary information for their effective preparedness and response during a Natech accident. Thus, such risk information deficiency creates a secondary meta-problem for individuals deriving from the exposure to the initial Natech accident risk itself. This research aims to contribute to the emerging topic of Natech risk communication by expanding the current knowledge about citizens' communicative behaviour towards chemical risk information disclosure, and further by proposing a serious game aimed at raising awareness about Natech accident risk and discussing about its management.

This study initially explored the determinants and sociodemographic influences that shape individuals' situational perceptions and communicative behaviour for Natech risk information. Japan and S. Korea have been selected for the comparative study because they share a comparable collectivistic sociocultural structure, yet they present important institutional differences in terms of chemical risk communication. S. Korea has recently updated their regulatory framework for the management of industrial accidents introducing requirements for public disclosure of chemical information, while Japan still has not.

This study used the interpretative framework of the Situational Theory of Problem Solving (STOPS). Complementary to STOPS, we explored individuals' perceptions concerning the Natech risk and their relationships with governments and companies regarding trust and decision-making power. Household questionnaire surveys were carried out in 2018 (Japan) and 2020 (S. Korea) to collect data from residential areas near prominent industrial parks: Kobe and Osaka in Japan, and Yeosu, Suncheon, Gwangyang and Ulsan in S. Korea. Structural Equation Modelling

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was employed to validate the conceptual models and analyse the results of the two surveys, while the differences between groups were assessed using inferential statistics. Regression analysis was used to investigate the influence of sociodemographic variables on factors that drive individuals' situational motivation to communicate about the issue.

Our research findings suggested that Natech accident risk is perceived as a concerning issue in both countries. However, Japanese are significantly more constrained in resolving the information deficiency meta-problem through communicating. In comparison, S. Korean respondents seemed to be more communicative and confident in responding to potential Natech accidents. Perhaps the chemical risk information regulation framework in S. Korea has contributed positively in alleviating the meta-problem of information deficiency. Trust in organisations and perceived decision power-sharing seemed to reduce citizens' concerns about the Natech risk information deficiency meta-problem. Finally, sociodemographic characteristics exhibited generally weak and insignificant influences on the factors that shaped citizens' situational motivation to communicate about Natech risk information.

Considering these findings this research explored the potential of serious gaming for Natech risk communication. This study proposed and developed EGNARIA: a novel, educational, role-playing game considering earthquake and tsunami scenarios that might cause subsequent chemical accidents. Players try to survive by taking disaster preparedness actions and responding correspondingly to the natural and chemical hazards they face. The game was designed to raise community awareness about Natech accidents, and generate a discussion among stakeholders about risk management strategies, chemical information disclosure and risk-informed decision-making. To assess the game's impact, a quasi-experiment was conducted with questionnaire surveys before and after a trial application with Kyoto University affiliates. The survey was structured based on STOPS measures to understand the game's impact on the players' communication behaviour regarding Natech risk. Our findings suggested an overall positive reception from players as an engaging, educational tool to introduce communities to Natech accident risk and discuss about its management. Participants noted that the game raised their awareness about Natech accidents, highlighted the importance of community participation and chemical information disclosure, and motivated them to actively search for and share information about Natech risk.

In sum, this study attempted to explore the communicative meta-problem of Natech risk information deficiency and in doing so provide some rudimentary empirical evidence for risk managers to pursue and foster chemical and Natech risk information disclosure as a way to alleviate the meta-problem. Additionally, a novel serious game for Natech risk awareness was developed and tested to aid risk communicators in opening the risk management discourse to communities.

氏　名	TZIOUTZIOS Dimitrios

（論文審査の結果の要旨）

本論文の主な目的は、リスクコミュニケーションの分野に焦点を当て、a)リスク情報開示に関する市民のコミュニケーション行動を調査することにより、自然災害が引き起こす化学事故（通称：Natech）に関する情報不足の問題を探ること、b)これらの複合自然災害・技術災害の参加型災害リスク管理を促進する方法として、シリアスゲームを提案すること、である。本論文では、Natechのリスク情報開示の欠如というコミュニケーション問題に関する理論的背景と研究ギャップを概説し、論文展開のための概念的段階を設定した。本研究のデータ収集にあたり、文献のレビューおよび日本と韓国におけるアンケート調査を開発し、実施した。分析手法としては、構造方程式モデリング、回帰分析、およびその他の統計的検定を行った。さらに、シリアスゲームの設計と改良のために、複数の専門家が試行的にゲームを実施し、試行的なゲームの前後に評価アンケートを実施した。本研究の主たる成果はいくつかの査読付きの国際学術誌や書籍に掲載されている。成果の要点は以下の通りである。

(1) 両国の個人の状況認識とコミュニケーション行動を決定する社会人口学的要因の影響を調査した。

(2) 問題解決の状況理論（STOPS）の解釈的枠組みを通して、個人の Natech リスク認識、公的・私的機関への信頼、統制相互性（意思決定権）を検討した。

(3) 本稿は、両国において Natech リスクの情報不足と Natech リスクが懸念される問題であることを示唆する実証的証拠を提供した。コミュニケーション行動については両国間で有意差が認められ、信頼と統制的相互性は個人の状況的コミュニケーション動機に正の影響を与え、社会人口学的特性は市民の問題についての状況的コミュニケーション動機を形成する要因に弱い、重要ではない影響を与えた。

(4) 以上の知見に基づき、参加型アプローチを促進する目的で、本論文は EGNARIA と称する地震と津波に関連する Natech シナリオを考慮した、新しい教育的ロールプレイングボードゲームを開発し、テストした。

本論文は、STOPS の解釈的枠組みを初めて Natech リスクコミュニケーションの文脈に適用し、検証することで、理論的にも重要な貢献がある。本論文の成果は、特に日本やその他の地域の人口密集地や工業地帯で大地震によって引き起こされる潜在的な Natech 事故のリスクを考慮すると、工学的かつ実用的な意義があると言える。以上のように、本論文は学術上、実際上寄与するところが少なくない。よって、本論文は博士（工学）の学位論文として価値あるものと認める。また、令和 4 年 4 月 25 日、論文内容とそれに関連した事項について試問を行って、申請者が博士後期課程学位取得基準を満たしていることを確認し、合格と認めた。