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# Intelligent Retrieval of Accident Knowledge for Chemical Process Safety Studies

Iskandar Halim[1*], Mokkawes Thirakorn[1], Ryan Teo Zhan Rong[2], and Shaik Salim[1]

[1]Institute of Sustainability for Chemicals, Energy and Environment (ISCE[2]),

Agency for Science, Technology and Research (A*STAR),

1 Pesek Road, Jurong Island, Singapore 627833, Republic of Singapore.

[2]Department of Chemical and Biomolecular Engineering,

National University of Singapore,

10 Kent Ridge Crescent, Singapore 119260, Republic of Singapore.

[*]E-mail: Iskandar_Halim@a-star.edu.sg

**ABSTRACT**

*Despite having access to extensive in-house and publicly available accident databases, companies rarely use them effectively to learn from past incidents and prevent future occurrences. One key reason is that most existing systems rely on simple keyword searches for specific text within the databases. As a result, relevant accident information is often overlooked, or the search returns information that lacks the proper context [1].*

*To address this challenge, we develop an intelligent information retrieval system. A structured ontology model capturing key aspects of accidents—location, date, event summary, causes, consequences, equipment, chemicals involved, and lessons learned—is constructed as knowledge graphs to represent the contextual relationships between accident attributes. The graphs are then populated with publicly accessible historical accident data from sources including eMARS [2], IChemE [3], and ARIA [4]. Finally, a large language model (LLM)-based retrieval system is developed to enable context-aware searches, allowing users to more effectively retrieve relevant past accidents and their associated lessons learned.*

*The system is designed to complement another intelligent tool, called HAZOP GenAI, which we previously developed to help automate HAZOP analysis [5]. In this context, the system can highlight potential accidents that have previously occurred because of process deviations. For example, the system can be prompted to retrieve information on past accidents involving ammonia releases caused by excessive flow to a storage tank that subsequently led to rupture. It then identifies similar historical cases from the database and presents the associated events, causes, consequences, and lessons learned. This information can provide valuable insights to help strengthen safeguards for safe plant operations.*

*The system can also be used to assist safety studies during process flowsheet development. It can highlight potential accident scenarios associated with specific design decisions, providing valuable safety insights during the early stages of process design.*

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**KEY WORDS**

*Process safety; Chemical accident database; Information retrieval; Artificial intelligence; Large language model*


**BIOGRAPHY**

Iskandar Halim is a Research Scientist at ISCE2, A*STAR. His research focuses on process systems engineering applications to support the design and operation of safe and sustainable chemical processes. His expertise involves the development of qualitative methods, mathematical modelling, process simulation, and optimization strategies to address complex engineering challenges. His research on systematic methodologies and intelligent systems for chemical process sustainability has been featured in leading journals. Notably, his project on decision-support systems for sustainable pharmaceutical supply chains received the IChemE Singapore Sustainability Award in 2017.

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