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"Flourish and Nurturing Sustainable Innovation for a Prosperous Nation"

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Editorial Board

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students and get some ideas to develop future innovation products.

Foreword Rector

Assalamualaikum warahmatullahi Wabarakatuh, Salam Sejahtera, Salam Malaysia MADANI and Salam UiTM Dihatiku.

In the name of Allah, the Most Gracious, the Most Merciful.

It is a great honor to welcome you to the Johor International Innovation, Invention, Competition, and Symposium 2024 (JIIICaS 2024). This event connects various disciplines, focusing on education and engaging educators, students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and determination to turn those ideas into reality. The remarkable projects showcased today highlight the dedication and spirit of all participants. Initiatives like this not only explore new technologies but also cultivate skills and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor Branch, we are fully committed to fostering a dynamic culture of innovation, promoting the commercialization of new products, and encouraging meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all sponsors, judges, the College of Computing, Informatics and Mathematics, UiTM Pasir Gudang Campus as the event organizer, as well as to the researchers and participants for their hard work in making this event a success. Let us continue striving for innovation and excellence. May the ideas presented today inspire us and lay the groundwork for future achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
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(A-PP011) FROM ALGEBRA TO INDUSTRY: ENHANCING SUPPLY CHAIN RESILIENCE WITH ZERO DIVISOR GRAPH

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ABSTRACT

In the field of algebra, specifically in graph theory and ring theory, the zero divisor graph is defined as a graph where its vertices are the zero divisors of a ring and two vertices are adjacent if and only if the product of the vertices is zero. This project paper explores the innovative application of the zero divisor graphs, a concept rooted in abstract algebra, to business mathematics, with a particular focus on enhancing supply chain resilience. In this paper, the fundamental principles of the zero divisor graphs and their construction are introduced, followed by showcasing the practical applications in supply chain management. The zero divisor graphs can be used to represent suppliers, manufacturers, and distributors as their vertices, with edges indicating dependencies between them. By analyzing this graph, a business can identify which supplier failures (zero divisors) could cause significant disruptions (zero product) in the supply chain. This insight allows the company to develop contingency plans, diversify suppliers, and improve overall supply chain resilience.

Keywords: zero divisor graph, supply chain resilience, business networks

1.0 INTRODUCTION

A graph is mathematically defined as a structure with vertices and edges (Bondy & Murty, 1976). To date, graphs are extensively used to visualize various real-life situations and assist in solving many real-world problems. For example, in airplane networks, graph theory is used to effectively optimize routes, leading to cost savings and improved efficiency. Airports are represented as nodes, and direct flights between them are represented as edges. Each edge can be weighted based on factors like distance, cost, or travel time. Another real-life example is in biology, where graphs are used to analyze protein-protein interactions. Proteins are treated as the nodes of the graph, and interactions between the proteins are the edges. This helps in providing a better understanding of the cellular processes and disease mechanisms.

Meanwhile, one of the graphs that are well-known in the field of algebra is the zero divisor graph. A zero divisor graph is defined as a graph where its vertices are the zero divisors of a finite ring, and two vertices are adjacent if and only if their product is the zero element of the ring (Anderson & Livingston, 1999). In this paper, the concept of the zero divisor graph is used to study the supply chain in business networks.

Supply chain refers to a network of facilities that produce raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system (Shukla et al., 2011). It can also be described as the entire spectrum of activities involved, from the supply of raw materials and resources for production to the production of products and the distribution of products to the end-users. Generally, the goal of supply chain management is to ensure efficient and timely delivery of products or services to the end consumers, which at the same time benefits all involved parties.

The supply chain encompasses the costs associated with conveying information, producing components, storing them, transporting them, and transferring funds, among other expenses. The overall cost of the supply chain tends to rise due to factors such as the significant capital required for operating global businesses, increasing real estate costs, and rising freight charges (Koh, 2006).

In this project paper, we suggest a method of enhancing supply chain resilience by using an algebraic approach, which is constructing the zero divisor graph.

2.0 OBJECTIVE

This study aims to describe the fundamental principles and mathematical foundations of zero divisor graphs in algebra and to explore and demonstrate how zero divisor graphs can be used to enhance supply chain resilience.

3.0 METHODOLOGY

This section outlines the methodology employed to explore the application of zero divisor graphs in enhancing supply chain resilience. A comprehensive literature review on zero divisor graphs and their mathematical foundations was conducted. Additionally, studies on supply chain resilience and network analysis techniques in supply chain management were surveyed to provide context and background for the research.

Next, the zero divisor is constructed for a supply chain network. The graph would visualize how the resilience of the supply chain can be enhanced by identifying and reinforcing critical components (zero divisors) through strategies like redundancy, diversification, and alternative paths.

4.0 RESULTS

In this section, a model of the zero divisor graph of a supply chain network is presented.

Supposed there exist a supply chain network where different parts work together to deliver products to customers. In this network, we have the ‘suppliers’, which are the companies that provide raw materials; ‘manufacturing plants’ which are the factories that turn raw materials into products; ‘distribution centres’ which act as the warehouses where products are stored before being sent to stores; and the ‘retailers’ or the stores where customers buy the products.

To construct the zero divisor graph showcasing the interconnection between the parts, each circle (vertex) on the graph represents one part of the supply chain (like a supplier or a retailer). Then, arrows (edges) are drawn between the vertices to show the connections between these parts. The diagram below shows an example of the zero divisor graph of a supply chain network.

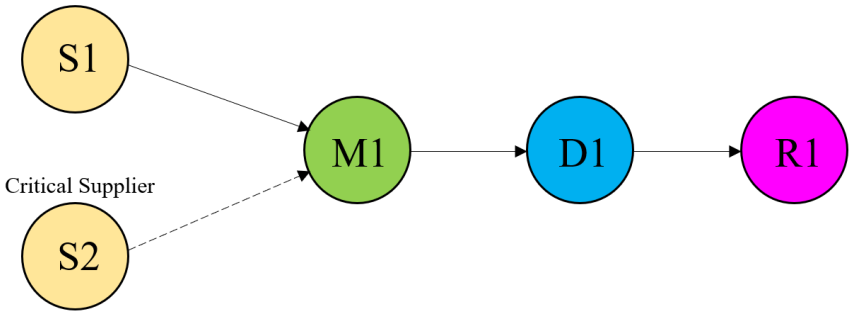

Figure 1: The zero divisor graph of a supply chain network

From Figure 1, it is shown that both Supplier 1 (S1) and Supplier 2 (S2) send raw materials to Manufacturing Plant 1 (M1). M1 needs materials from both suppliers to make products. After M1 makes the products, it sends them to Distribution Center 1 (D1) for storage and distribution. Finally, D1 sends the products to Retailer 1 (R1), where they are available for customers to purchase.

A critical point that needs to be highlighted from the graph is the vertex S2. The Supplier 2 (S2) is a critical part of this supply chain because if S2 fails or has a problem (like running out of materials or facing delays), Manufacturing Plant 1 (M1) won't get all the materials it needs, which means it can't produce the products as demanded. This would cause a ripple effect affecting the whole supply chain, including Distribution Centre 1 (D1) won't have products to store or send out and Retailer 1 (R1) won't have products to sell to customers.

Hence, the construction of the zero divisor graph of the supply chain network plays a significant role in understanding the vulnerability of the network. By identifying and focusing on critical points like S2, businesses can take steps to ensure these parts of the supply chain are well-supported. For instance, businesses might find backup suppliers or increase inventory to avoid disruptions in their supply chain. This way, if something goes wrong, the whole system will not collapse, and they can keep supplying their products to customers.

This graph is a simple way to see how everything is connected and which parts are the most crucial to keep the supply chain running smoothly. Besides identifying disruptions from suppliers that can interrupt a supply chain network, by plotting the zero divisor graph, critical components (zero divisors) can also be reinforced through strategies like redundancy, diversification, and alternative paths.

5.0 CONCLUSION

This research demonstrates the potential of zero divisor graphs as a valuable tool for analyzing and enhancing supply chain resilience. By identifying critical components and dependencies within the supply chain, such as key suppliers or distribution centers, businesses can better understand where vulnerabilities lie. This understanding enables more effective strategies to mitigate risks, such as diversifying suppliers, adding redundancies, and developing alternative routes. The application of zero divisor graphs thus offers a powerful approach to strengthening supply chains, ensuring that they can withstand disruptions and continue to deliver products efficiently to customers.

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