

# A Systematic Literature Review in Enterprise Architecture for Railway Supply Chain of Malaysia Transportation Industry

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## Abstract

Systematic literature review is a clearly stated scientific research method designed to answer a specific research question. Systematic literature review in Enterprise Architecture (EA) for Railway Supply Chain (RSC), involves a comprehensive search for encountering the 4<sup>th</sup> Industrial Revolution (IR 4.0). Yet, the research on the domain of knowledge, methodology point of view, ontology point of view and epistemology point of view in EA for RSC is still inadequate. Therefore, this research planned to identify the current domain of knowledge, contribute comprehensive paradigm on the IR 4.0, data value and future action for decision making utilize by decision makers in EA for RSC. We utilize divergent keywords to compile the raw information based on articles published in Scopus, ScienceDirect, Emerald and Google Scholars about the field concerning EA for RSC. The information was analysis by utilizing Microsoft Excel. The outcome of the systematic literature review will provide high-level technology guidelines and best practice technology used in EA for RSC on producing high-integrated infrastructure flow and transition stages in performance for business growth. Furthermore, it will become a research paradigm map for future researchers, academicians, students and technology professionals in the related field of study.

**Keywords:** Enterprise Architecture; Information Management; Information System; Malaysia Transportation Industry; Railway Supply Chain; Systematic Literature Review.

## I. INTRODUCTION

In today's highly competitive global economy, actionable Enterprise Architecture (EA) is crucial to success in accelerating technology excellence [1]. Information System (IS) has been key to Railway Supply Chain (RSC) rapid development [2]. Yet while many industries have made substantial investment in EA infrastructure, few industries are taking advantage of the powerful EA guideline they have at their fingertips [3]. It must cater our RSC with the skills, competencies, and knowledge that have driven the prosperity and growth of the industry itself.

This is because Information Management (IM) is only part of a truly successful, industry wide EA strategy [4]. Decision

making needs an analytic culture and strong industry IS collaboration and partnership among many other factors that make up a winning towards EA initiative in RSC [5]. RSC wants to obtain this intention of enhancing an advanced industry in Malaysia by 2030, where we must boost both quality and access to EA within the industry [6]. Many studies have shown the accelerating technology excellence with global presence towards the core industry of the RSC in line with Malaysia Transportation Industry (MTI) to elevate knowledge to an unprecedented level [7]–[9].

MTI is committed to pioneer and drives knowledge advancement with respect to RSC for high quality railway industry delivery with a global presence [10]. The surge standard about MTI and aspect has been one of the maximal within the global and RSC is rated greatly amongst our Asian rival [11]. MTI must adapt EA in order to grow within a progressively competing world economic surroundings that move towards 4<sup>th</sup> Industrial Revolution (IR 4.0). This includes the transformation of RSC system.

The technology of tomorrow will desire a leading significance on RSC by providing key strategies to accelerate global recognition that will provide pathways for EA practitioners and learners locally and globally to support higher technology higher value competitiveness [12]. EA requires a strategic change from the aspect of the MTI integrating the IR 4.0 with the industry and community to make RSC content and deliver more holistic and dynamic [8], [13]. The EA for RSC industry and ideas perspective to drive innovation is a requirement.

Therefore, utilizing technology and Information and Communication Technology (ICT) for enabling Knowledge Management (KM) beyond boundaries that creates, shares and utilize the knowledge to improve the growth of MTI needs a dynamic EA model with clear outcomes of RSC on supporting and incentive needs on critical context [14]. Hence it is clearly depicted the strategic objective to drive the outcome and critical enablers for those strategies to be successfully implemented in RSC [15]. That is why we have adopted EA, which will transform the RSC system to contest these modern threats.

We would like to state that the number of articles published in the RSC field has increased rapidly and they need an ambitious, clear and compelling intention to pilot MTI through 2030 and beyond with IR 4.0 approaches. RSC cannot transform alone

and needs EA to strategize decision making on it, we conducted a systematic literature review. Pioneering future technology for RSC needs strategic knowledge and innovation for the future through the state-of-the-art technologies of EA for future industries [16]. Therefore, we need to systematically review the literature on EA for RSC, by indicating the research questions as below:

RQ1: What is the architecture utilize in EA for RSC?

The architecture utilizes in EA for RSC presently focuses on TOGAF 9.2. EA methodologies can be categories as Zachman Framework, Federal EA, TOGAF 8.0 and Gartner.

RQ2: What is the benchmark in RSC that can be analysis by EA?

The benchmark in RSC that can be analysis by EA provides information which can boost the performance through time to value, governance direction, maturity framework, vendor neutrality, process completeness, business focus, partitioning direction, information availability, practice direction, taxonomy completeness, prescriptive catalogue, and reference-framework direction.

RQ3: What is the fundamental architecture paradigm provided by EA for RSC?

The fundamental architecture paradigm provided by EA for RSC focus on the technology architecture, application architecture, business architecture and data architecture that get the most value out about EA investments.

RQ4: What type of MTI uses EA in its supply chain activity?

Type of MTI uses EA in its supply chain activity can be categorized as land, sea, and air. To be specific the land focus on rail transport, sea focus on maritime and air focus on aerospace that utilizes EA in their supply chain.

In order to truly pioneer future technology, MTI must have the passion and drive to advance in strategic knowledge and technology foresight [17]. Therefore, this research question will answer which industry has used less and found the gap in it. The objective of this research is to provide high impact technical research using EA for RSC with a comprehensive systematic literature review that produces solution to the industry now and beyond.

## II. SYSTEMATIC LITERATURE REVIEW PROCESS

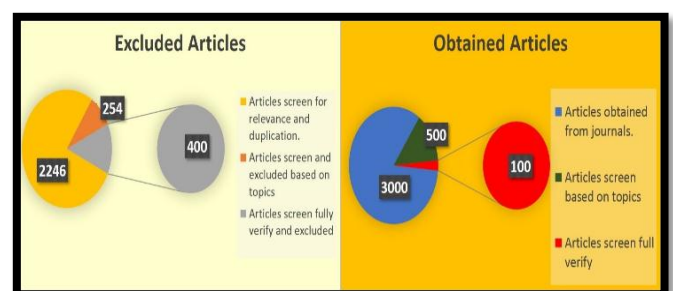
A systematic literature review evaluates and compiles the research available on a certain field that a researcher is studying [18]. Therefore, the systematic literature review for this research focuses on EA for RSC. Systematic literature review explains a specific methodological perspective and reduces the risk of bias [19]. Moreover, it focusses on identifying the protocol that will answer research questions clearly. We have implemented six (6) process to conduct a systematic literature review for our research, which has been tabulated in Table 1.

**Table 1.** The Systematic Literature Review Process

Step	Process	Justification
1	Select a topic	The topic for this research focuses on EA for RSC.
2	Search the literature	We utilize divergent keywords to compile the raw information based on articles published in Scopus, ScienceDirect, Emerald and Google Scholars about the field concerning EA for RSC.
3	Develop the argument	We design research questions to be answered by the review on EA for RSC that is an unbiased, reproducible and transparent way.
4	Survey the literature	We focus on seven (7) years particularly from 2013 to 2019 via acquire suitable aspects on EA, RSC, IS, IM and IR 4.0.
5	Critique the literature	Excluding and including studies that related to EA for RSC based on the research questions.
6	Write the review	Address the knowledge gaps and provide recommended practice on EA for RSC.

Based on Table 1, the systematic literature review process indicates the knowledge map that been synthesis and analyzed on EA for RSC. This comprehensive process will guide the researcher, academicians, and professionals to conduct a systematic literature review. Moreover, we can establish a dynamic EA framework based on the analysis gain through systematic literature review on EA for RSC that will ensure MTI on a holistic view with necessary value, technology, and knowledge to prevail within competitive world. Yet, we are designing and developing high technology output through establish EA for RSC on technically competent and industry driven.

Therefore, we have collected 3000 articles from Scopus, ScienceDirect, Emerald and Google Scholars about the field concerning EA for RSC by filtering them into the relevance and duplicating article as 2246 articles so the remaining articles will be 754. Then, we filtered the remaining article based on the topics and obtained 500 articles. The full articles through the systematic review will be 100 articles related to EA for RSC, as shown in Figure 1.



**Fig. 1.** Pie Chart of Systematic Review on EA for RSC

We focus on seven (7) years particularly from the year 2013 to 2019 via acquire suitable aspects on EA for RSC. The highest publication was in the year 2015 with 20 articles followed by the year 2019 with 18 articles. In the year 2018 was 16 articles and the year 2017 were 15 articles. 14 articles were published in the year 2013 on the field. The lowest number of articles published was in the year 2016 with 8 articles followed by 9 articles in the year 2014 related to EA for RSC, as shown in Figure 2.

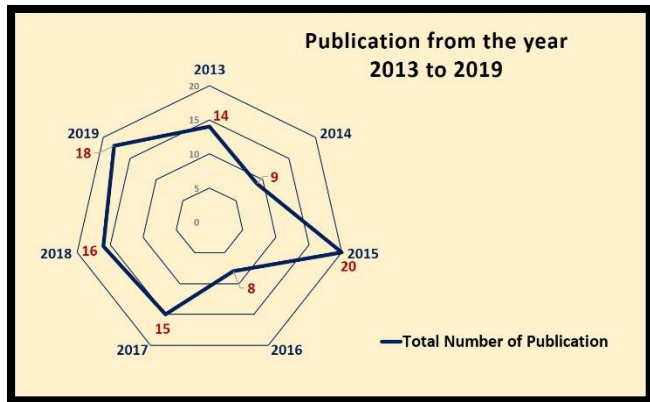


Fig. 2. Radar Chart of Publication from the year 2013 to 2019

Moreover, we have analyzed on the domain of knowledge of IS that emphasis on transforming a consistent and roadmap towards IR 4.0 that make high impact contribution to MTI and the world. Therefore, Figure 3 will show the paradigm map of the domain of knowledge on the RSC system from the year 2016 to 2019.

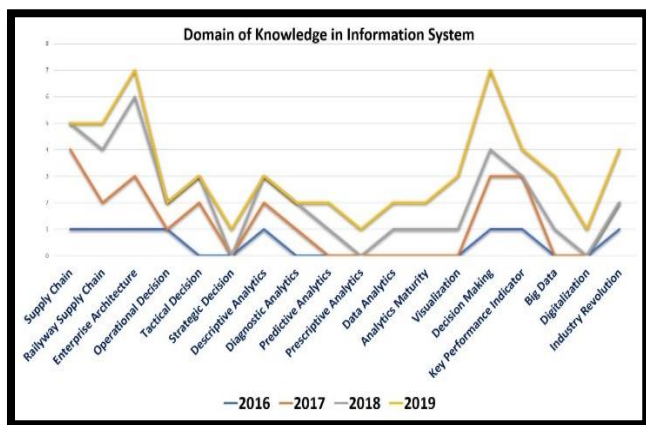


Fig. 3. Line Graph of Domain of knowledge publication from the year 2016 to 2019

Furthermore, we utilize divergent keywords to compile the raw information based on articles published in Scopus, ScienceDirect, Emerald and Google Scholars about the field concerning EA for RSC for the duration of the year 2013 to 2019 in various journals as shown in Figure 4.

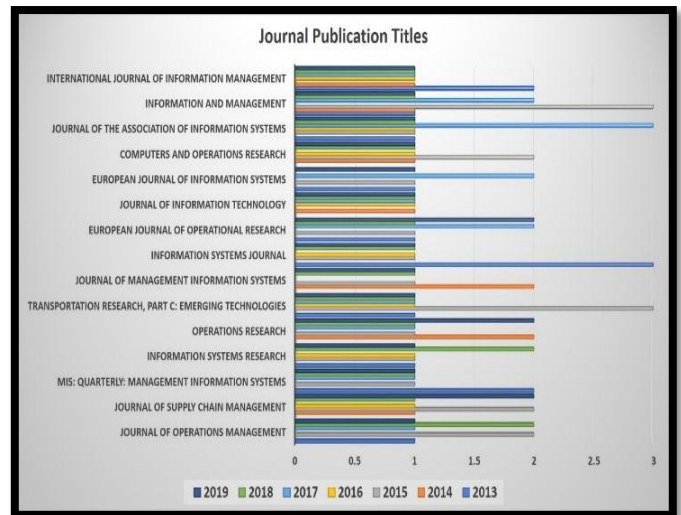


Fig. 4. Bar Chart of Journal publication from the year 2013 to 2019

Based on Figure 4, about 100 articles were obtained after verifying through systematic review related to EA for RSC. This article came from 15 journals that have high impact citation and aspiration to transform the RSC system. We also analysis that Information and Management journal has the highest publication related to the field with 9 articles published during the year 2013 to 2019. Journal of the Association of Information Systems and Transportation Research, Part C: Emerging Technologies has published 8 articles during the year 2013 to 2019 with the related domain field.

Thus, we have clustered the domain of knowledge for these 100 articles based on EA for RSC and approaches utilizes for EA on transforming the RSC system on quality, efficiency, decision skills, and knowledge. Moreover, we need to target on enablers for the RSC integument critic factors on digitalization and decision making through utilizing EA. Hence, the implementation is what matters most and strengthening RSC in the transformation that lies ahead needs to focus based on the cluster, as shown in Figure 5.

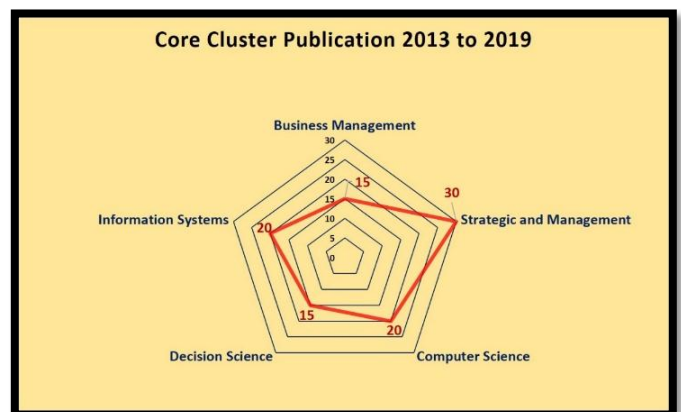


Fig. 5. Radar Chart of Core cluster publication from the year 2013 to 2019

### III. RESULT OF THE ANALYSIS

Through the IR 4.0 shifts identified, the MTI aspires to produced holistic and proactive RSC that nurtures industry creators on technologies and greater dynamism towards transition stages that enables Malaysia to complete globally in RSC. Therefore, we need to systematically review the literature on EA for RSC, by indicating the research questions as below:

RQ1: What is the architecture utilize in EA for RSC?

The architecture utilizes in EA for RSC presently focuses on TOGAF 9.2. The analysis resulted in 30% of articles in EA for RSC use TOGAF 9.2 as their implementation and execution of new technologies for making high impact decision making with the industry. Moreover, the analysis resulted 25% of articles use TOGAF 8.0 as their strategic knowledge in EA for RSC. The Zachman Framework resulted 20%, followed by Gartner 15% and Federal Enterprise Architecture 10% in EA for RSC, which has been tabulated in Table 2.

**Table 2.** The Architecture Utilizes in EA for RSC

Architecture	Article Utilize in EA for RSC (%)
Zachman Framework	20
Federal Enterprise Architecture (FEA)	10
TOGAF 8.0	25
Gartner	15
TOGAF 9.2	30

RQ2: What is the benchmark in RSC that can be analysis by EA?

The benchmark in RSC can be analysis by EA through twelve (12) core benchmark. Based on the systematic review that we performed, the analyses resulted that (1) time to value 9% articles, (2) governance direction 8% articles, (3) maturity framework 6% articles, (4) vendor neutrality 10% articles, (5) process completeness 11% articles, (6) business focus 12% articles, (7) partitioning direction 8% articles, (8) information availability 15% articles, (9) practice direction 6% articles, (10) taxonomy completeness 5% articles, (11) prescriptive catalogue 4% articles and (12) reference-framework direction 6% articles, which has been tabulated in Table 3.

**Table 3.** The Benchmark in RSC through EA Analysis

Benchmark	Article Utilize in EA for RSC (%)
Time to Value	9
Governance Direction	8
Maturity Framework	6
Vendor Neutrality	10
Process Completeness	11
Business Focus	12
Partitioning Direction	8
Information Availability	15
Practice direction	6
Taxonomy completeness	5
Prescriptive Catalogue	4
Reference-framework direction	6

RQ3: What is the fundamental architecture paradigm provided by EA for RSC?

The fundamental architecture paradigm provided by EA for RSC focus on the technology architecture, application architecture, business architecture and data architecture that get the most value out about EA investments. The business architecture resulted in 28% of articles that align with the industry on structured, capabilities and information to gain the industry goal. The data architecture resulted 26% articles that guide data integration towards bridging industry strategy and drive the outcome.

Application architecture resulted in 22% articles that focus on critical enablers on industry application towards manageable, scalable and reliable on high impact data flow for the decision-making process. The technology architecture resulted 24% articles that report the operation and infrastructure of the industry contribution through aligning EA strategy with industry goals, which has been tabulated in Table 4.

**Table 4.** Architecture Paradigm on EA for RSC

Architecture Paradigm	Article Utilize in EA for RSC (%)
Business Architecture	28
Data Architecture	26
Application Architecture	22
Technology Architecture	24

RQ4: What type of MTI uses EA in its supply chain activity?

Type of MTI uses EA in its supply chain activity can be categorized as land, sea, and air. To be specific the utilization of EA in their supply chain for land focus on rail transport which resulted from 25% articles, sea focus on maritime which resulted 32% articles and air focus on aerospace which resulted 43% articles.

Based on the analysis we can conclude that rail transport is still lacking in implementing EA in their operation and need a critical EA team or EA experts to meet the industry needs as shown in Table 5. RSC needs to improve its data quality, so decision makers trust the EA solution for molding the industry to face IR 4.0 attributes.

**Table 5.** Type of MTI Uses EA for Supply Chain Activity

Type of MTI	Industry Category	Article Utilize in EA for RSC (%)
Air	Aerospace	43
Land	Rail Transport	25
Sea	Maritime	32

#### IV. FINDING BASED ON THE SYSTEMATIC LITERATURE REVIEW

The MTI has mature over the past few years [20]. Last 5 years, the industry has contrived important growth within international perception on a crucial aspect such as aerospace and maritime. These performances are proof of the benchmark and drive about the Malaysia industry towards facing IR 4.0, counting the broad contribution the government has contrived. But MTI recognizes that the system will demand to manage derive to reside ahead of the global trends. Therefore, disruptive technologies are needed with the industrialization of awareness performance to adequately change the RSC from what it is today.

Adapting MTI to prosper within this ever-changing and complex future will desire an equitably major transformation of how the RSC system currently operates. In 2016, the MTI focus on EA for RSC towards becoming a high transportation industry. The results have shown that the use of EA for RSC is still at the beginning stage and needs development stages on the framework core values. We need to glance at driven outcomes that provide input to the scholar, academicians, researchers, and experts towards EA for RSC that makes positive changes to the industry in passionate the field of advanced technology, act as a critical thinker and avid problem solver during decision making process.

The results of this systematic review about current progress and performance on EA for RSC shows the establishment of the strengths and weakness of the industry in utilizing technologies towards facing IR 4.0. Furthermore, the systematic literature review finding indicates that EA desired to haul the RSC system to the next level of the High Technology High Value (HTHV) approach. Therefore, to design and develop an HTHV framework, we need the core strategy in holistic perspective that expands the overall system and broadening access to quality through implementing EA for RSC.

#### V. CONCLUSION

MTI has reached a gross higher in the industry that link-up the benefits of RSC growth that drive the outcome through EA. Yet, critical enablers for those strategies need to be implemented in RSC to strengthen and mind set of one in decision making in the industry itself. Therefore, the results obtained through this systematic review based on the research question have the emphasis that RQ1 on architecture utilizes in EA for RSC focus on TOGAF 9.2 followed by RQ2 on the benchmark in RSC that can be analysis by EA through twelve (12) indicators.

RQ3 on the fundamental architecture paradigm provided by EA for RSC has four (4) architectures and RQ4 type of MTI uses EA in their supply chain activity that justifies as three (3) types. Based on this research question, we have identified the key enabler that can be practice and applied through EA for RSC that thrive MTI towards encountering IR 4.0.

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#### REFERENCES

- [1] T. Iyamu, "Implementation of the enterprise architecture through the Zachman Framework.," *J. Syst. Inf. Technol.*, vol. 20, no. 1, pp. 2–18, 2018.
- [2] M. Jayakrishnan, A. K. Mohamad, and A. Abdullah, "The Taxonomy of Enterprise Architecture towards High Technology High Value Approach In Malaysian Transportation Industry," *Int. J. Civ. Eng. Technol.*, vol. 9, no. 11, pp. 351–368, 2018.
- [3] F. Rahimi, J. Götze, and C. Møller, "Enterprise architecture management: Toward a taxonomy of applications," *Commun. Assoc. Inf. Syst.*, vol. 40, no. 1, pp. 120–166, 2017.
- [4] S. Dang, D.D. and Pekkola, *Problems of enterprise architecture adoption in the public sector: root causes and some solutions*. Springer, Cham., 2017.
- [5] M. Jayakrishnan, A. K. Mohamad, F. R. Azmi, and A. Abdullah, "Adoption of business intelligence insights towards inaugurate business performance of Malaysian halal food manufacturing," *Manag. Sci. Lett.*, vol. 8, no. 7, pp. 725–736, 2018.
- [6] M. Jayakrishnan, A. K. Mohamad, and A. Abdullah, "Enterprise Architecture Embrace Digital Technology in Malaysian Transportation Industry," *Int. J. Eng. Adv. Technol.*, vol. 8, no. 4, pp. 852–859, 2019.
- [7] D. H. Olsen and K. Trelsgård, "Enterprise Architecture Adoption Challenges: An exploratory Case Study of the Norwegian Higher Education Sector," *Procedia Comput. Sci.*, vol. 100, no. 1877, pp. 804–811, 2016.
- [8] K. Kasemsap, *The role of information system within enterprise architecture and their impact on business performance*. IGI Global., 2018.
- [9] M. Jayakrishnan, A. K. Mohamad, and A. Abdullah, "Digitalization Approach Through An Enterprise Architecture For Malaysia Transportation Industry," *Int. J. Civ. Eng. Technol.*, vol. 9, no. 13, pp. 834–839, 2018.

- [10] MAMPU, “Blueprint for 1Government Enterprise Architecture A Quick Guide to 1GovEA,” *Malaysia Adm. Mod. Manag. Plan. Unit*, p. 36, 2017.
- [11] H. Nur azaliah, Nazri kama, “Enterprise Architecture Development And Implementation In Public Sector: The Malaysian Perspective,” *J. Theor. Appl. Inf. Technol.*, vol. 88, no. 1, pp. 176–188, 2016.
- [12] M. Jayakrishnan, A. K. Mohamad, and A. Abdullah, “Journey of an Enterprise Architecture Development Approach in Malaysian Transportation Industry,” *Int. J. Eng. Adv. Technol.*, vol. 8, no. 4, pp. 765–774, 2019.
- [13] R. Mayer, N., Aubert, J., Grandry, E., Feltus, C., Goettelmann, E. and Wieringa, “An integrated conceptual model for information system security risk management supported by enterprise architecture management.,” *Softw. Syst. Model.*, pp. 1–28, 2018.
- [14] W. Omar, “Transformation Plan 2015-2020,” *Dep. Stat. Malaysia*, vol. 1, no. 1, p. 79, 2017.
- [15] M. Jayakrishnan, A. K. Mohamad, F. R. Azmi, and A. Abdullah, “Implementation of business intelligence framework for Malaysian halal food manufacturing industry towards initiate strategic financial performance management,” *Manag. Sci. Lett.*, vol. 8, no. 10, pp. 1059–1076, 2018.
- [16] M. Jayakrishnan, A. K. Mohamad, and M. M. Yusof, “Understanding Big Data Analytics ( BDA ) and Business Intelligence ( BI ) Towards Establishing Organizational Performance Diagnostics Framework,” *Int. J. Recent Technol. Eng.*, vol. 8, no. 1, pp. 128–132, 2019.
- [17] N. Razak, “Rancangan Malaysia Kesebelas 2016-2020,” *Percetakan Nas. Malaysia Berhad*, vol. 1, no. 2, pp. 1–40, 2016.
- [18] M. Al-Moslmi, T., Omar, N., Abdullah, S. and Albared, “Approaches to cross-domain sentiment analysis: A systematic literature review.,” *IEEE Access*, vol. 5, no. 1, pp. 16173–16192, 2017.
- [19] J. Van Laar, E., van Deursen, A.J., van Dijk, J.A. and de Haan, “The relation between 21st-century skills and digital skills: A systematic literature review.,” *Comput. Hum. Behav.*, vol. 2, no. 7, pp. 577–588, 2017.
- [20] M. I. M. Aziz, S.A., Kassim, R. and Masirin, “Railway Development and the Impact to Malaysian Economy.,” *Jour Adv Res. Dyn. Control Syst.*, vol. 10, no. 6, 2018.