Enterprise Architecture for Smart Enterprise System

A Quest for Chili Agrosystem

Meuthia Rachmaniah[1], Arif Imam Suroso[2]*, Muhamad Syukur[3], Irman Hermadi[4]
Computer Science Department, Bogor Agricultural University, Bogor, Indonesia[1, 4]
School of Business, Bogor Agricultural University, Bogor, Indonesia[2]
Agronomy and Horticulture Department, Bogor Agricultural University, Bogor, Indonesia[3]

***Abstract*—The chili agrosystem faces many challenges, and the enterprise architecture (EA) artifacts as the building block of a chili enterprise system (ES) are not exist. This research is a qualitative systematic literature review as part of developing intelligent ES to examine chili's production, consumption, and price. The first step toward ES development is recognizing worthy chili EA and EA frameworks that characterize existing chili market conditions. The study aims to answer three research questions (RQ) and uses a state-of-the-art approach, employing predetermined keywords, to six research databases and data gathered from the corresponding institutional agencies. The findings on RQ1 revealed eight dynamics chili main supply chain patterns and data segregation among institutional agencies. The RQ2 disclosed numerous studies on EA; however, none offered for the chili agrosystem. In addition, the RQ3 results are multiple and expose different EAF characteristics. Again, no study considers its applicability to the chili agrosystem. To conclude, the strength of enterprise architecture for the chili enterprise system is the resulting deliverables that fall into three categories. These are factors of the chili agrosystem, enterprise, and architecture factors. Of many available frameworks, the Zachman framework - The Ontology gives more offerings.**

Keywords*—Chili agrosystem; enterprise architecture; intelligent enterprise; supply chain; Zachman framework

I. Introduction

Chili is an essential complementary ingredient for most Indonesian daily cuisines. Most chili farmers will plant chili when prices are high, resulting in an ample supply of chili and causing prices to fall. On the other hand, chili farmers do not grow chili when prices are low, resulting in a scarcity of chili, and eventually, prices will rise. Chili pests and diseases can also influence the supply of chili. Reference [1] analyzes the socio-economic and agro-ecological aspects of chili production. The results show that harvest losses due to pests and diseases are high. Also, the chili agribusiness risks for chili farmers are production, price, economic, and institutional risks [2]. These risks are interrelated. These risks that bring negative impacts are production risks due to plant diseases, markets due to price volatility, and monetary risks faced by chili farmers.

The chili supply chain has not been implemented efficiently and effectively in its management [3]. Most distribution chain actors face several barriers, such as losses, decreased products, and inefficiencies in the delivery period. The study of [4] stated that the chili supply chain is lengthy and unoptimized, including not entrusting the Village Owned Enterprises (called Bumdes) and the Indonesian Farmers Shop (called TTI). Reference [5] had identified 23 profiles of agro-industrial enterprises. The classification characteristics used are the location in the food chain and industry (field of activity), organizational forms and company law, company size, trade turnover, volume level, and technical and technological innovation base of the company (facilities and production technology used). Other characteristics are features of the company's structure (complexity, the presence of vertical and horizontal integration), the level and possible likelihood of production diversification, the company's price segment, the degree of product differentiation, the width and geography of market presence, the nature of influence in the market (the company's position in the market).

The importance of this research is longing for reconciling chili price volatilities due to supply and demand discrepancy. Here, establishing an intelligent enterprise system for chili agrosystem is an intended way of managing its supply to align with the market demand. Chili farmers and chili trade operators often faced obstacles in the distance, the high logistical costs to distribute seeds, fertilizer, pest medicines, and chili production from production centers to all areas in Indonesia. It creates a complex distribution of chili from producers to end consumers. Moreover, the condition of infrastructure is inadequate, especially in remote areas, and lack of technology to extend the shelf life of chilies to prevent them from rotting before reaching end consumers throughout Indonesia. The red chili supply chain requires a model compatible with various supply chain patterns occurring in Indonesia.

This study is part of the research on establishing intelligent enterprise systems to examine the production and consumption of chili. The first step towards its development is to recognize suitable chili enterprise architecture (EA) that characterizes existing conditions. The purpose of our study is incredibly inquisitive in:

- identifying the current problems in the existing chili agrosystem,
- investigating EA and its EA framework (EAF) suitable for the chili agrosystem, and
- determinating open challenges and areas for enhancement.

The study's direct audience for this paper is threefold. Firstly, we target researchers interested in a state-of-the-art overview of the area of the chili agrosystem. Secondly, we aim at researchers in the quest for the most helpful chili enterprise

*Corresponding Author.

architecture. Thirdly, we target chilies' farmers and or groups of farmers and its supply chain actors and stakeholders that would like to find out suitable enterprise architecture framework to improve the value of farmer exchange rates.

II. Proposed Method

This study used a state-of-the-art approach using previous latest ideas and methods from 2015-to 2020. To do this, we conducted a systematic literature review to lead our choice in determining the chili agrosystem enterprise architecture of available evidence and topic, including identifying shortcomings, inclinations, and voids in knowledge and indicating the direction it is beneficial to prompt further research. This section illustrates the foundation of this state-of-the-art by defining the state-of-the-art research questions and search keywords. We use a systematic literature review to answer the following state-of-the-art (STA) research questions.

A. *State-of-the-Art Research Questions*

EA and EAF are not new problems, and various methodologies, methods, and approaches offer to describe EA and EAF practices, including its implementation case studies. Our research aimed to ascertain the current issue of chili agrosystem and the quest for EA and EAF application for chili agrosystem, in particular, to answer the following research questions:

- RQ1 What is the Indonesia chili agrosystem outlook?
- RQ2 What is the state-of-art of EA?
- RQ3 What is the state-of-the-art of EAF applicable for the chili agrosystem?

In this study, the word ‘agrosystem outlook’ represents a series of activities and processes to characterize, develop, and maintain the delivery of fresh produce from farmers or grouped farmers to end consumers from the agri-business perspective. The words state-of-the-art of EA and EAF follow the description in Miriam Webster Dictionary. State-of-the-art determines the level of development (such as devices, procedures, processes, techniques, or science) that is achieved at a given time and can be used due to modern methods. Our study determines the state-of-the-art mostly in its implementation success factors.

B. *Search Process*

The search process is carried out by searching relevant articles using the list of keywords depicted in Fig. 1. The search applied to six research databases: IEEE Xplore, ACM Digital Library, Science Direct-Elsevier, Taylor and Francis, Springer Link, and Google Scholar, published between 2015 and 2020.

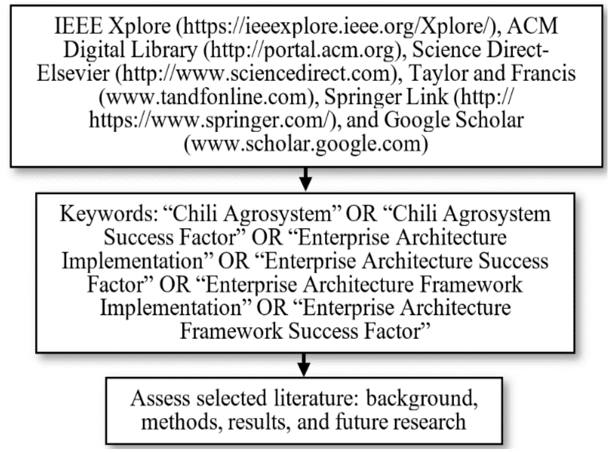


Fig. 1. Keywords Search flow Applied on Various Research Databases.

C. *Scope of the State-of-the-Art Conduction*

Our study defines the construct and guidelines for managing the STA as follow:

- Inclusion criteria: English peer-reviewed journal papers and conferences proceeding.
- Exclusion criteria: Book, Book Chapter, Indonesian peer-reviewed studies, government publication, studies irrelevant to the research questions, duplicate studies (by content and title), and short paper (e.g., poster).

Concerning the exclusion criteria, prospect papers that are not a specific approach for chili and practice are not within the scope of this research. This study intends to focus on practices and critical success factors of chili agrosystem and implementation of EA and EAF. Table I present the application of the query based on the keywords: “chili agrosystem,” “chili agrosystem success factor,” “enterprise architecture implementation,” “enterprise architecture success factor,” “enterprise architecture framework implementation,” or “enterprise architecture framework success factor.” Table II depicted the citations of the selected 32 papers obtained using Google Scholar.

TABLE I. Studies Retrieved through Various Search Engines Conducted in June 2020

Source	**Paper Found**	**Candidate**	**Selected**
IEEE Xplore	359	6	1
ACM Digital Library	7	6	3
Science Direct – Elsevier	9	6	4
Taylor and Francis	3	-	-
Springer Link	35	11	5
Google Scholar	333	51	19
Total	746	80	32

TABLE II. SELECTED PAPER RECENT CITATIONS

Reference	Cited	Reference	Cited	Reference	Cited
[1]	9	[16]	18	[27]	18
[2]	3	[17]	13	[28]	12
[3]	4	[18]	34	[29]	40
[4]	2	[19]	2	[30]	65
[5]	3	[20]	107	[31]	9
[10]	85	[21]	22	[32]	6
[11]	32	[22]	19	[33]	37
[12]	15	[23]	2	[34]	2
[13]	134	[24]	36	[35]	191
[14]	20	[25]	29	[36]	4
[15]	15	[26]	76		

III. RESULT AND DISCUSSION

A. RQ1 – Chili Agrosystem Outlook

The need for chili (red chili and cayenne pepper) for Indonesia's large cities with one million or more is around 800,000 tons/year or 66,000 tons/month. During the festive season or religious holiday, the need for chili usually increases by about 10-20% of regular requirements [6]. An enormous chili consumption per month indicates the need for national chili production and consumption system integrated with planting time management. The Ministry of Agriculture collects data and information on the production and area of chili commodity land, the Central Statistics Agency (BPS) handles export and import data, and the Ministry of Trade bears chili prices on the domestic and international markets.

Red chili land area from 2014-to 2018 experienced a decrease of -3.99%. On the contrary, the chili harvested area experienced an increase in growth of 22.50% (Fig. 2). Production of red chili and cayenne peppers grew by 0.04% for red chilies and 14.75% for cayenne peppers. The productivity of cayenne pepper experienced positive growth of 13.07%, while the productivity of red chili experienced a negative growth, which decreased by 0.13%. However, the productivity of red chili is better when compared to the productivity of cayenne pepper.

The consumption of red chili commodities is relatively high, especially in periods that coincide with religious holidays. According to [7] data, the highest red chili consumption per capita per month occurred in the province of West Sumatra (0.59 kg/month), followed by Bengkulu province (0.44 kg/month) and Banten province (0.42 kg/month) (Fig. 3.a). Whereas the highest level of consumption of red chili per ton per year in 2017 occurred in Banten province (93,234 tons/year), followed by West Java province (61,657 tons/year) and North Sumatra province (55,194 tons/year). Regardless of its consumption, in general, the national supply and demand projection showed a surplus (Fig. 3.b). Nevertheless, price fluctuation occurs every year.

Chili plantations spread in almost all provinces in Indonesia. According to [8], the three largest large chili production centers in 2018 are West Java (274,037 tons), Central Java (171,796 tons), and North Sumatra (155,835 tons) (Fig. 4). The three largest cayenne pepper production centers in 2018 are Banten (453,338 tons), West Kalimantan (20,530 tons), and DI Yogyakarta (141,771 tons).

Fig. 4 indicates that the province determines the priority of the type of chilies to be planted. For example, West Java chili production in 2017 was 134,910 tons, but in 2018 there was no data available for the production of cayenne pepper; on the contrary, in the year 2018, West Java's red chili production was the highest in Indonesia, which was 274,037 tons. In 2018 the production of red chili in Banten province was only 6,712 tons, but in the same year, Banten produced the highest production' of cayenne in Indonesia, which was 453,338 tons.

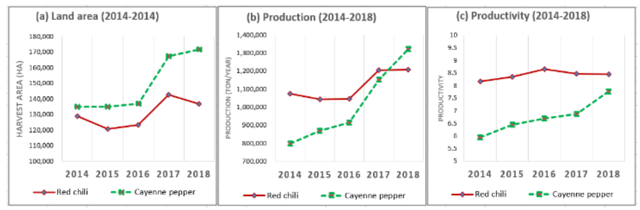


Fig. 2. (a) Land Area, (b) Production and (c) Productivity of Chili and Cayenne Pepper Year 2014-2018.

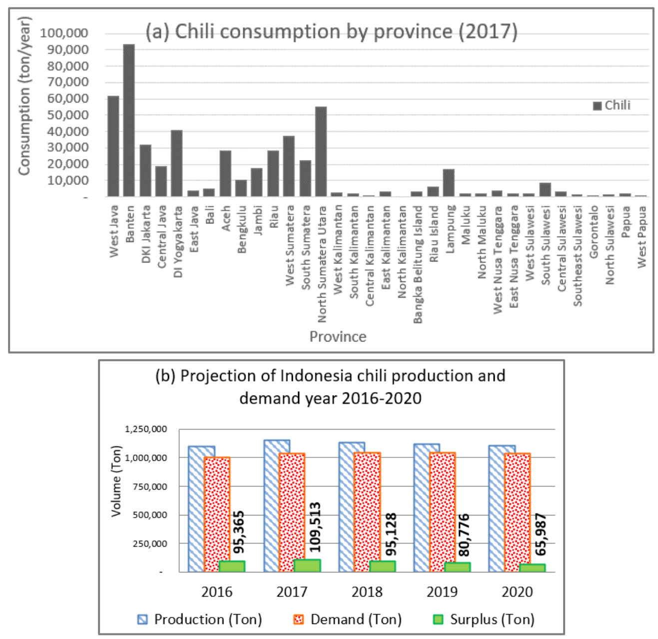


Fig. 3. (a) Year 2017 Consumption of Red Chili (Adapted from Agriculture Ministry, 2019) and (b) Year 2016-2020 Chili Projection of Supply and Demand (Adopted from [9]).

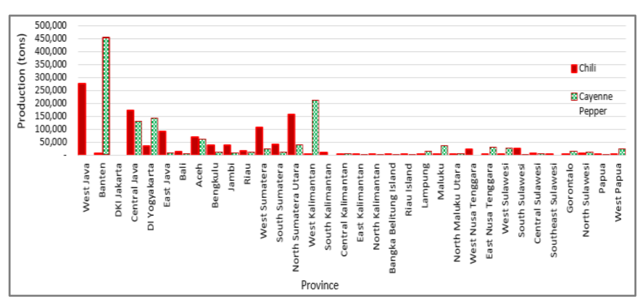


Fig. 4. Red Chili and Cayenne Pepper Production by Province Year 2018.

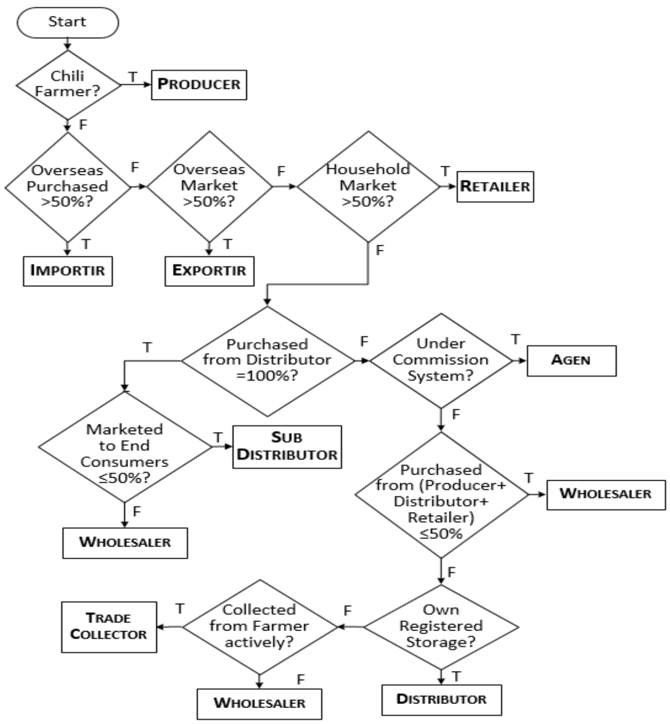


Fig. 5. Flowchart Determination of Chili Supply Chain Actors (T-True, F-False) (Adopted from [9]).

In 2018, the Indonesia Central Bureau of Statistics, known as Badan Pusat Statistik (BPS), surveyed the pattern of red chili distribution implemented by agrosystem red chili actors in 2009, 2015, 2017, and 2018 [9]. The actors of the red chili agrosystem consist of two groups, namely businesses and non-trade businesses. Trade businesses comprise medium, large and small companies that act as distributors, sub-distributors, agents, wholesalers, merchants, exporters, importers, or retailers (Fig. 5). Also, non-trading businesses/companies are red chili farmers as producers.

The BPS 2018 survey observed eight patterns of Indonesia's red chili trade system upstream to downstream. The most common red chili trade system pattern in 17 provinces in Indonesia is Pattern No. 1, which involves four actors in the red chili trade system (Table III). The most minor chili trade system operators are Pattern No. 6 and Pattern No. 8, which involve three red chili trade system actors. Almost all trading patterns involve retailers to end consumers. Meanwhile, DKI Jakarta has the most different supply chain patterns of the red chili trade system: red chili from outside the province rather than from farmers (producers) directly. DKI Jakarta obtains red chili from West Java, Central Java, and East Java provinces. In this survey, the definition of end customers is households, other business activities (restaurants, restaurants, catering businesses, hospitals, and hotels), processing industries, and government and non-profit institutions.

The BPS 2018 survey also analyzed the margins of trade and freight (MTF) merchant compensation as a supplier of goods. The MTF value is the difference between sales with the purchase value or the price difference from producers to final consumers. The MTF calculation considers the main trade patternsn*(see* Table III). Nationally, the MTF of red chili is 47.10% [9]. Regarding prices reaching the final consumer, the province with the lowest MTF is Riau Island province, with a total MTF of 15.25%, while the highest MPP occurs in South Kalimantan province, with a total MTF of 130.76% (Fig. 6). The MTF values greater than 100% also occur in Bengkulu and Maluku provinces. The high MTF value is mainly affected by transportation costs.

Data and information on the production and land area of strategic food commodities are managed separately by the Ministry of Agriculture, export and import data by the Ministry of Trade (Ministry of Trade), and the strategic food commodity price data by the Central Statistics Agency (knowns as BPS). The Ministry of Agriculture, BPS, and the Ministry of Trade has a separate work unit called the Data Center and Information System (Pusdatin). The Pusdatin manages the database of strategic food commodities following the domain of its authority. Also, to monitor price movements, in the year 2017, Bank Indonesia launched the National Strategic Food Price Information Center (PIHPS) on the hargapangan.id (Fig. 7). The PIHPS provides information on strategic food commodity prices daily; the enumeration is from Monday to Friday at 09:00-11:00 AM, reported to Bank Indonesia at 10:00-12:00 AM, and published at 01:00 PM West Indonesia Time. The number of samples is two retailers per traditional and modern market (primary market) per commodity in 82 districts/cities locations.

TABLE III. MAIN RED CHILI DISTRIBUTION PATTERN IN INDONESIA YEAR 2018 (ADOPTED FROM [9])

Pattern No.	Supply Chain Pattern	No. of Provinces
1.	Farmer → Trade Collector → Retailer → End Consumer	17
2.	Farmer → Trade Collector → Wholesaler → Retailer → End Consumer	4
3.	Farmer → Wholesaler → Retailer → End Consumer	5
4.	Farmer → Agent → Wholesaler → Retailer → End Consumer	2
5.	Other Provinces → Wholesaler → Retailer → End Consumer	1
6.	Farmer → Retailer → End Consumer	3
7.	Farmer → Distributor → Retailer → End Consumer	1
8.	Farmer → Trade Collector → End Consumer	1

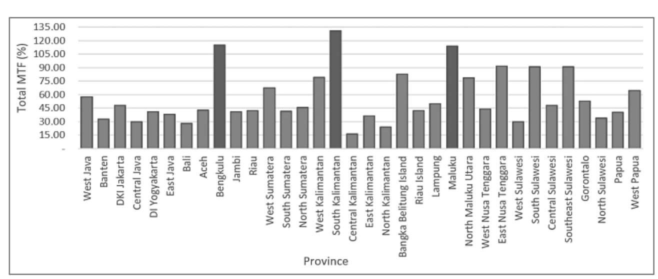


Fig. 6. Margin of Trade and Transportation Costs by Province (Adopted from [9]).

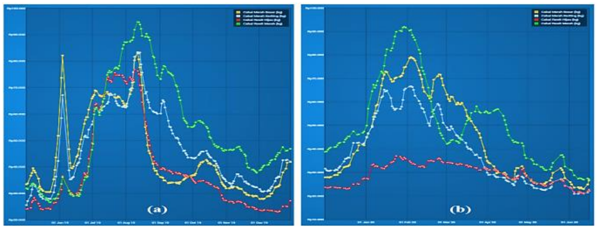


Fig. 7. The Menu Prices of Producers on Chili Commodities in West Java in the Graphic Report Format showed Fluctuating Prices: (a) Period May 2, 2019 until December 30, 2019 and (b) Period December 2, 2019, up to June 16, 2020.

B. RQ2 – State-of-the-Art of Enterprise Architecture

An enterprise architecture (EA) is a series of structured models that represent the building blocks of an enterprise system. The architecture framework simplifies processes and guides architects in all areas of architectural development, providing a set of conventions, principles, and practices. Reference [10] successfully identified 15 EA artifacts used by the 14 EA stakeholders interviewed. The artifacts are used to align with the goals and objectives of EA utilization in every part of the EA process and potential users that will use the produced artifacts. Further, [11] conducted an empirical analysis of 27 organizations and succeeded in identifying 24 EA artifacts that benefit organizations, explaining their practical use, and analyzing the empirical validity of the most popular EA conceptualization. Additionally, [12] reveal the post-implementation review apply to artifacts practices aiming to evaluate: the initiation of the implemented artifacts, the management and conducting EA artifact development, and the control of future change to the developed artifacts. The practices in the first category are business strategy, risk management, planning, and architectural method. The practices in the second category are governance, continuity, and stakeholder satisfaction. Lastly, the practices in the third category are alignment, architecture technique, management, and integration.

Reference [13] conducted a Monkey platform survey of 747 respondents (311 responded, 133 completed) and identified four success factors for EA management (EAM). These are the quality of EAM products, quality of EAM infrastructure, quality of EAM service and delivery, and EAM organization anchoring. Also, [13] suggested further research related to applying four EAM principles, which are determining EAM infrastructure, creating stakeholder awareness, providing high-quality EA products and services, and ensuring stakeholder commitment. Prior to that, [10] study review on over 100 special publications identifies six critical success factors (CSFs). Of the six CSFs, three CSFs successfully support the EA program implementation process. These are monitoring and compliance, commitment to using architecture, and consultation and communication.

The complexity of EA implementation and its bureaucratic business functions and complex IT structures become challenging problems for organizations. Reference [14] uses axiomatic design as a systematic approach for EA to analyze current enterprise capability and map the requirement of business, data, application, and technology layer of EA as the design domain aligned with the organization's strategic goals. Meanwhile, [15] measured implementation factors from the points of view of the experts and practitioners. The measurement comprises 27 factors that construct the 6-factor of internal process, 6-factor of learning and growth, 6-factor of authority support, 3-factor of cost, 3-factor of technology, and 3-factor of talent management. Analysis results have shown that there is no significant agreement between the experts and the practitioners except for rules and process of internal process category, the political influence of authority support category, and financial resources of cost category factors.

Further, [16] affirmed that EA program success derives primarily from how architecture is practiced rather than what is practiced. Meanwhile, [17] develop the CSF model of team capability, communication, top management commitment, technology and infrastructure, and governance. Reference [17] model indicated that governance gives the highest factor in successful EA implementation.

The study of [18] obtained 13 critical success factors (CSF) enterprise architecture implementation for the public sector (Fig. 8). In general, CSF that influences the successful implementation of EA in the public sector is technical development (68% articles) and frameworks and methodologies (50% articles). It is unavoidable that the people factor influences successful EA implementation. A study of [19] identified seven types of people factors. Five people factors have proven to have an association with successful EA implementation. These are skilled EA talent, centralized enterprise architect team, talent management plan, talent retention program, and EA learning culture. Surprisingly, the remaining two factors with a minor association with EA implementation are trained EA talent and certified EA talent.

To obtain benefits from EA, the findings of [20] highlight the importance of EA service capability and dynamic capability in creating benefits from EA. Reference [20] gives three recommendations. Firstly, how dynamic capabilities are activated through EA service capability and how projects and organizations benefit. Secondly, longitudinal studies are needed to fully understand how and why EA service capability develops over time, that is, reflecting the maturity of EA. Lastly, longitudinal studies will lead to a better understanding of the process to achieve organizational benefits. Also, [21] suggests three future works to carry out. Firstly, group the current EAIM problem into three main categories: modeling, development, and maintenance. Secondly, the identification of factors is evaluated from surveys of different EA project stakeholder groups (Fig. 9). Lastly, to carry out the effectiveness of EA implementation using factors and practices that affects the EA implementation.

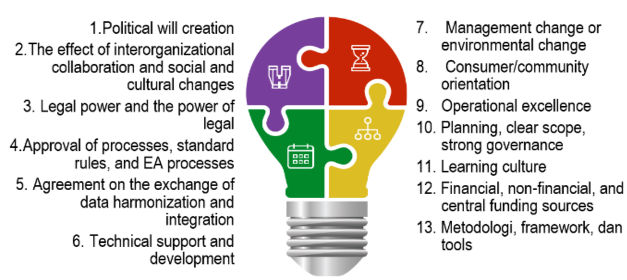


Fig. 8. CSF Implementation of EA in Public Sector (Adopted from [18]).

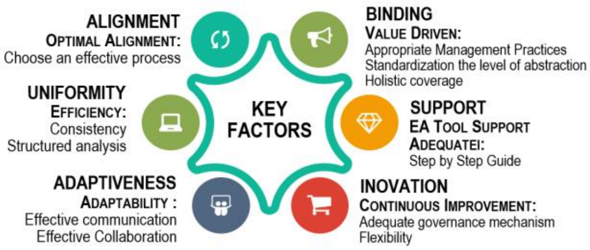


Fig. 9. Key Factors that Influence the Effectiveness of EAIM (Adopted from [21]).

The increasing flow of information and system integration in organizations and along the trade chain is one of the main challenges organizations need to address. Reference [22] proposed EA 4.0, which is an extended EA for the context of Industry 4.0. The EA 4.0 component consists of the EA model, data from enterprise information systems and IoT devices, and advanced analytics. His study reflects the Model4Insight platform that is still under development. For the record, EA 4.0 requires an EA model at a more detailed level, requires new skills, and works together with experts or data scientists.

Meanwhile, [23] uses a hybrid evaluation method for enterprise architecture that considers the organizational culture aspect encompassing the management sustainability variable consisting of governance, continuity, integration, and maintenance. Further, [24] uses EA to improve investment quality in information technology (IT). According to [25], top-quartile organizations use more EA artifacts to prepare IT investment decisions, specifically heat maps, policies, roadmaps, business capability models, and landscape diagrams.

One framework and approach that fits all does not apply in the case of EA because the different fields in which EA operates have unique/different field-specific requirements and specifications [25]. They suggest further research: (i) SOA requires further research on developing methods and models, and tools that directly measure service response time at higher accuracy; (ii) Issues and challenges to EA design; (iii) EA for healthcare needs to address aspects of organizational culture and professional culture; and (iv) Technology and methodology issues to guide the development of EA. Also, communication along the wide-distributed geography gives other challenges that might create a knowledge gap.

In [26] successfully identified current issues on cloud terminology, complexity theory, agile or adaptation, big data, things, entrepreneurship, intelligence, and sustainability. Based on their systematic literature review results, [26] recommended the need for further research on issues related to whether there was a mismatch between EA's academic efforts and EA in practice. Besides, trend analysis shows the number of publications in specific industries, such as health, manufacturing, and government issues. To fully understand the differences and similarities across the industry, further research has to be more detailed. Nevertheless, [27] developed Agile enterprise architecture (AEA) for geographically distributed Agile development (GDAD) environment. The study creates measurement model evaluation and 26 measures comprise of AEA (7-item), communication efficiency (5-item), communication effectiveness (4-item), on-time completion (2-item), on-budget completion (2-item), software functionality (3-item), and software quality (3-items).

C. RQ3 – State-of-the-Art of EA Framework

The architecture framework has several benefits [28]. The benefits are supporting stakeholders' decision-making about enterprise design and operations, improving users' trust that using reference architecture will be successfully applied to projects, and facilitating enterprise design communication. The architecture framework may be applied to various systems and enterprise scenarios. Another benefit of the architecture framework is building a general way to organize, interpret, and analyze architectural descriptions and identify architecture problems, generic stakeholders, viewpoints, and levels of abstraction. Besides, the architecture framework implements reuse and provide unified and unambiguous terminology definitions.

EA frameworks are differentiated according to their field of application [28]. Some EA frameworks frequently used are the Zachman Framework, the Open Group Architecture Enterprise (TOGAF) Architecture Development Method (ADM), Federal Enterprise Architecture Framework (FEAF), Department of Defense Architecture Framework (DoDAF). Ministry of Defense Architecture Framework (MODAF), Adaptive Enterprise Architecture Framework, and EA3 Cube Framework. In essence, the development of many EA Frameworks uses the Zachman Framework as its foundation (see Fig. 10 for EA framework evolution). Reference [29] mentioned that the existing EAF is too overwhelming for small-medium enterprises (SMEs). Hence, [29] developed a CHOOSE metamodel, an acronym for "maintain Control, employing a Holistic Overview, that is based on Objectives and kept Simple, of your Enterprise." Following evaluation and validation through five SMEs, CHOOSE metamodel includes only four essential concepts (goal, actor, operation, object), each applying to four primary EA focus (what, why, who, how). That supports [26] study that most EAF focus on EA implementation and EA artifacts development lacks implementation evaluation methods.

Reference [30] chose the Zachman framework in developing a system-of-system (SoS) architecture. DoDAF and MODAF are not suitable for SoS, while the TOGAF, FEAF, and Zachman frameworks are suitable. Based on the Zachman framework guidelines, the development of architectural SOS is best to use agent-based simulation integrated with SysML and UML. Meanwhile, [31] conducted an Agile modeling language study and provided a diagrammatic integration of machine-readable from several aspects of the Zachman framework. In [31] study, the 'What' aspect of dealing with the concept of Linked Enterprise Data environments, such as graph servers, graph databases, and RESTful HTTP requests with PHP-based programming languages with SPARQL queries for client requests. Agile modeling method engineering (AMME) creates and develops Agile modeling tools related to semantics, syntax, and functionality, namely environments such as ADOxx commonly used in prototyping. The primary key lies in the AMME, which provides tools to make prototyping in agile modeling [31] quickly.

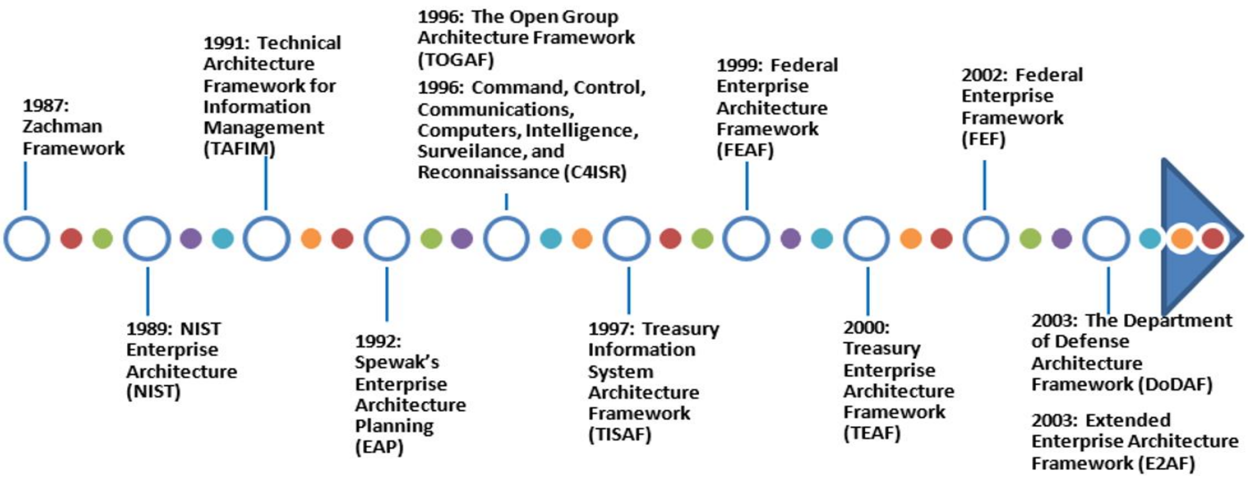
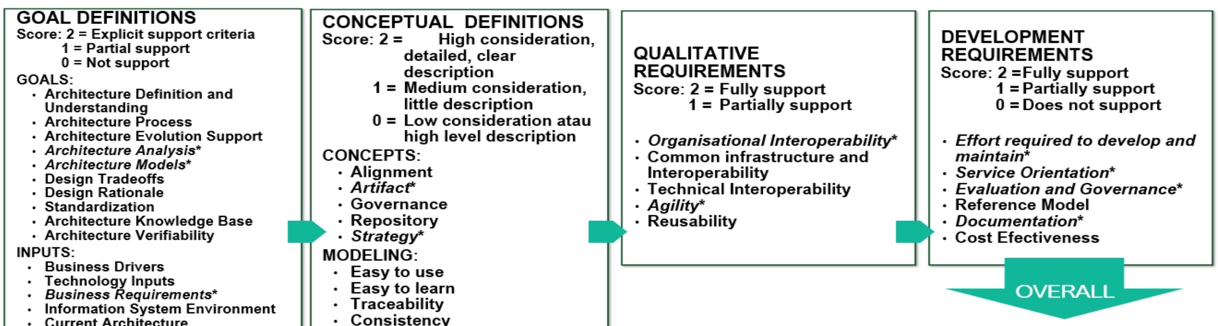


Fig. 10. The Evolution of EA Framework (Adopted from [28]).



Requirement	ZF	TOGAF	FEAF	DoDAF	MODAF	NAF	TEAF	GEAF	RM-ODP	SOA
GOAL	27	52	42	46	46	47	38	50	2	52
CONCEPTUAL	22	23	14	13	15	20	8	10	12	33
QUALITATIVE	7	7	8	6	6	5	3	5	4	7
DEVELOPMENT	10	14	16	10	10	12	7	12	8	14
TOTAL	66	96	80	75	77	84	56	77	77	106

Fig. 11. Stages of Comparative Analysis on ten EAFs and their Final Results (Adopted from [9]).

At present, there are more than 100 EAF available and used by four user groups: industry, government, open-source, and proprietary defense [32]. On critical IT infrastructure (CITI) design, [32] selected the EAF producing the ten most popular EAFs, resulting from usage percentage of the Zachman framework (25%), SOA (15%), TOGAF (11%), DoDAF (11%), FEAF (9%), British Ministry of Defense Architecture Framework (British MODAF) (2%), NATO Architecture Framework (NAF) (1%), TEAF (1%), Gartner EAF (GEAF) (3%), and ISO Open Distributed Processing-Reference Model (RM-ODP). Further, [32] scored each criterion on goals definitions, conceptual definitions, qualitative requirements, and development requirements (Fig. 11). Comparative analysis of [32] shows that the highest total overall score for CITI design is SOA and TOGAF. Almost all EAFs surveyed ignored or had less description of the rationale architecture design, even though needed in CITI design. Some EAFs include documentation of system boundaries and assumptions. Therefore [32] stated that the foundation of architecture must include criteria, benefits, and risks.

To propose an effective EA implementation methodology (EAIM) using the list of products in each EAIM phase (Fig. 12), [33] firstly identified EAIM criteria and compared its uses on four EAF (Table IV). Considering the complexities of EA implementation, [33] exploration found that no effective methodology existed. Nevertheless, the proposed EAIM aligns business and IT, integrates application and infrastructure, defines appropriate objectives and vision, governance plan, and step-by-step guidelines.

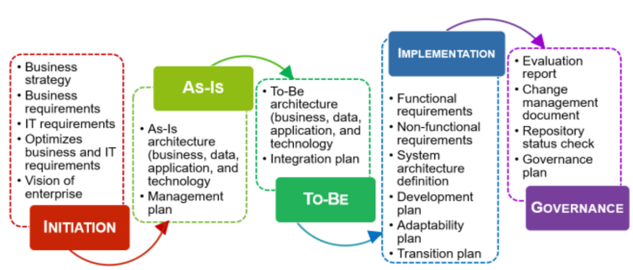


Fig. 12. List of Products by EAIM Phase to Measure Effective EAIM (Adopted from [33]).

TABLE IV. COMPARATION OF EAIM CRITERIA AMONG EAF

Identified EAIM Criteria	EAP	TOGAF	FEAF	DoDAF
Iterative	-	++	-	-
Management process	-	-	-	-
Maintenance process	-	+	-	-
Ability to work with other EAF	+	++	-	-
Requirement management process	-	++	-	-
Step-by-step guidelines	+	+	+	+
Easy to understand	+	-	+	+
Non-functional requirement	-	++	-	++
Complexity management	-	-	-	-
Supporting tool	+	+	-	+
Governance	+	++	+	-
Type-usage	++	++	-	-
Repository	++	++	++	++
Easy to implement	+	-	+	+

a. Note: ++ Fully consider/support/exist/all/easy;

b. + Partly consider/partly support/partial/somewhat/easy;

c. - Not consider/not support/not exist/particular/difficult

In [34] selected the EAF for e-Government by applying the Multiple Criteria Decision Making (MCDM) method with the Analytical Hierarchy Process (AHP) tool to select four EAFs, namely the Zachman framework, FEAF, TOGAF, and TEAF. The AHP results showed the highest ranking of EAF are Zachman framework (30.76%), FEAF (25.23%), TOGAF (24.13%), and TEAF (19.13%). The results of the matrix combination show the preference attributes for the Zachman Framework, which are the preferred framework attributes, knowledge base, and architecture evolution support.

In [35] explored EA in the future using the Zachman framework version 3.0 - The Enterprise Ontology perspective. The world's challenges are even more significant with a global market that affects social transformation and government instability. The results of the exploration of [35] are fourfold. First, various non-technical domains must contribute to the progress of EA. Secondly, insight into systems thinking and complexity science. Thirdly, there is no significant progress on EA related to new enterprise realities (e.g., virtual, boundaryless, heterogeneous culture, and retention knowledge). Lastly, many advances have been discussed but are still very early. Reference [36] identified 14 criteria to evaluate EAF artifacts. These criteria are applied for the Zachman Framework, TOGAF, FAF, EAP, The Enterprise Architecture, and DoDAF by three designated experts with overall perceived results 90.87% usable, 97.62% relevant, and 90.48% correct.

As the implications, further study using manageable chili enterprise systems requires bringing farmers closer to end consumers that enhance farmers' welfare [37]. Farmers might utilize a predictive analytics model to plan optimal chili production schedules and plan logistics and distribution chains to several regions to reduce the production cost and increase profit for the farmer [38] [39]. Chili agrosystems may be considered family companies and small-medium enterprises with a multidimensional concept with several variables, including actors, attributes (motivation and activities), and consequences or outcomes [40]. The smart enterprise system has to build knowledge foundations, bearing in mind the technology-assisted organization, leadership, and management models [41]. Therefore, enterprise architecture implementation and critical success factors and artifacts may address using various methods (Fig. 13).

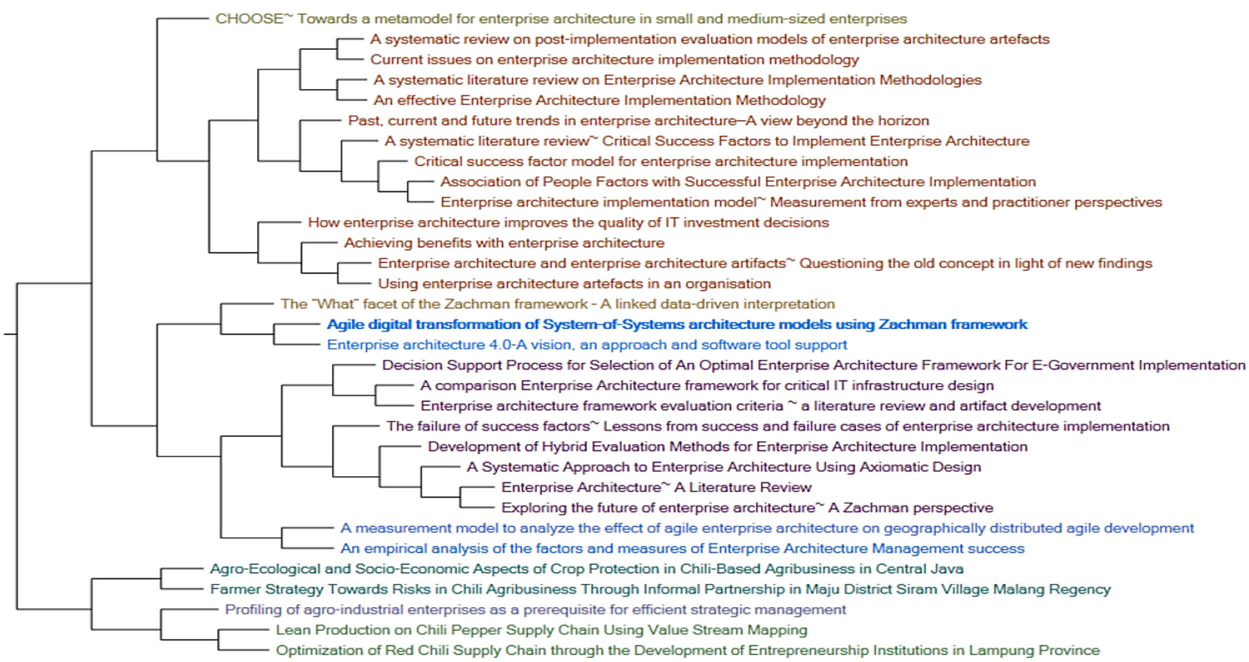


Fig. 13. Horizontal Dendogram of State-of-the-Art Results.

IV. CONCLUSION

This study's main findings are that using an enterprise architecture framework might provide better solutions to guide the supply chain management in governing the price volatility of the chili agrosystem. Even though the proposed methods do not represent the entire publication, they suffice the goals. Chili agrosystem implicates multiple mechanisms, such as the array of heterogeneous production centers and productivity, dynamic and variably supply chain patterns, unappealing trade and freight margin, and segregated chili datasets among associated institutions.

There are diverse open challenges and areas for further studies. Conforming to the results, we contribute three lines of work, particularly if we consider that some problems are to be solved. Firstly, enterprise architecture is unique depending on the nature of the enterprise: government institutions, non-governmental agencies, e-commerce, virtual organization, or any organizations. Hereupon, resolving the current problem can probably be separated into three primary classes containing modeling, development, and maintenance. Next, each enterprise architecture framework has its well-defined characteristics.

Consequently, enterprise architecture choices are not general but depend on the nature of the enterprise. Last, the chili agrosystem outlook demands the availability of an integrated creation of a chili dataset for chili farmers or groups to access. The existence of the chili dataset can better enhance the economic, social, institutional, and environmental appearances of the chili agrosystem.

In conclusion, the strength of enterprise architecture relies upon three factors of the resulting deliverables. These are enterprise, influencing, and architecture factors. Nevertheless, of many available frameworks, the Zachman framework gives more offerings for developing an intelligent enterprise system of fresh chili. We suggest a thorough study investigating these factors to achieve a suitable framework for the chili agrosystem. Further study is also required on various supply chain patterns using a Zachman enterprise architecture framework to improve the efficacy of the chili agrosystem.

ACKNOWLEDGMENT

This work was supported by the Computer Science Department, Faculty of Mathematics and Natural Science, IPB University.

REFERENCES

[1] Mariyono J. Agro-Ecological and Socio-Economic Aspects of Crop Protection in Chili-Based Agribusiness in Central Java. Agriekonomika. 2017;6(2):120.

[2] Hidayat K. Farmer Strategy Towards Risks in Chili Agribusiness Through Informal Partnership in Maju District Siram Village Malang Regency. Agric Soc Econ J. 2017;17(1):6–15.

[3] Perdana T, Hermiatin FR, Pratiwi ASN, Ginanjar T. Lean Production on Chili Pepper Supply Chain Using Value Stream Mapping. Mimb J Sos dan Pembang. 2018;34(2):311–20.

[4] Barusman ARP, Soewito, Romli K. Optimization of Red Chili Supply Chain through the Development of Entrepreneurship Institutions in Lampung Province. Rev Integr Bus Econ Res. 2019;8(2):233–43.

[5] Lomachenko TI, Kokodey TA. Profiling of agro-industrial enterprises as a prerequisite for efficient strategic management. IOP Conf Ser Earth Environ Sci. 2020;421(2).

[6] Kementerian Perdagangan. Profil Komoditas Barang Kebutuhan Pokok dan Barang Penting - Komoditas Cabai. Jakarta: Kementerian Perdagangan; 2016.

[7] Badan Pusat Statistik. Distribusi Perdagangan Komoditas Cabai Merah Indonesia Tahun 2018. Badan Pusat Statistik. 2018. 1–97 p.

[8] Pusdatin - Pusat Data dan Sistem Informasi Pertanian. Outlook Cabai - Komoditas Pertanian Subsektor Hortikultura. Pus Data dan Sist Inf Pertan. 2020;1–51.

[9] Datamikro K, Statistik BP. Indonesia - Survei Sosial Ekonomi Nasional 2017 Maret (KOR). 2018.

[10] Niemi E, Pekkola S. Using enterprise architecture artefacts in an organisation. Enterp Inf Syst. 2017;11(3):313–38.

[11] Kotusev S. Enterprise architecture and enterprise architecture artifacts: Questioning the old concept in light of new findings. J Inf Technol. 2019;34(2):102–28.

[12] Nikpay F, Ahmad R, Rouhani BD, Shamshirband S. A systematic review on post-implementation evaluation models of enterprise architecture artefacts. Inf Syst Front [Internet]. 2016;1–20. Available from: http://dx.doi.org/10.1007/s10796-016-9716-0.

[13] Lange M, Mendling J, Recker J. An empirical analysis of the factors and measures of Enterprise Architecture Management success. Eur J Inf Syst. 2016;25(5):411–31.

[14] Behrouz F, Fathollah M. A Systematic Approach to Enterprise Architecture Using Axiomatic Design. In: Procedia CIRP. 2016.

[15] Bakar NAA, Harihodin S, Kama N. Enterprise architecture implementation model: Measurement from experts and practitioner perspectives. Colloq Inf Sci Technol Cist. 2016;0:1–6.

[16] Hope T, Chew E, Sharma R. The failure of success factors: Lessons from success and failure cases of enterprise architecture implementation. SIGMIS-CPR 2017 - Proc 2017 ACM SIGMIS Conf Comput People Res. 2017;21–7.

[17] Rouhani BD, Ahmad binti R, Nikpay F, Mohammaddoust R. Critical success factor model for enterprise architecture implementation. Malaysian J Comput Sci. 2019;32(2):2019.

[18] Ansyori R, Qodarsih N, Soewito B. A systematic literature review: Critical Success Factors to Implement Enterprise Architecture. Procedia Comput Sci. 2018;135:43–51.

[19] Bakar NAA, Hussien SS. Association of People Factors with Successful Enterprise Architecture Implementation. Int J Eng Technol. 2018;7(4.31):52–7.

[20] Shanks G, Gloet M, Asadi Someh I, Frampton K, Tamm T. Achieving benefits with enterprise architecture. J Strateg Inf Syst. 2018;27(2):139–56.

[21] Nikpay F, Ahmad binti R, Rouhani BD. Current issues on enterprise architecture implementation methodology. Internattional J Soc Educ Econ Manag Eng. 2015;9(1):112–5.

[22] Aldea A, Iacob ME, Wombacher A, Hiralal M, Franck T. Enterprise architecture 4.0-A vision, an approach and software tool support. Proc - 2018 IEEE 22nd Int Enterp Distrib Object Comput Conf EDOC 2018. 2018;1–10.

[23] Noviansyah B, Arman AA. Development of Hybrid Evaluation Methods for Enterprise Architecture Implementation. Proceeding - 2018 Int Conf ICT Smart Soc Innov Towar Smart Soc Soc 50, ICISS 2018. 2018;1–4.

[24] Van den Berg M, Slot R, van Steenbergen M, Faasse P, van Vliet H. How enterprise architecture improves the quality of IT investment decisions. J Syst Softw. 2019;152:134–50.

[25] Gorkhali A, Xu L Da. Enterprise Architecture: A Literature Review. J Ind Integr Manag. 2017;02(02):1750009.

[26] Gampfer F, Jürgens A, Müller M, Buchkremer R. Past, current and future trends in enterprise architecture—A view beyond the horizon. Vol. 100, Computers in Industry. 2018.

[27] Alzoubi YI, Gill AQ, Moulton B. A measurement model to analyze the effect of agile enterprise architecture on geographically distributed agile development. J Softw Eng Res Dev. 2018;6(1).

[28] Kale V. Enterprise Process Management Systems: Engineering Process-Centric Enterprise Systems using BPMN 2.0. CRC Press Taylor and Francis Group. 2019.

[29] Bernaert M, Poels G, Snoeck M, De Backer M. CHOOSE: Towards a metamodel for enterprise architecture in small and medium-sized enterprises. Inf Syst Front. 2016;18(4):781–818.

[30] Bondar S, Hsu JC, Pfouga A, Stjepandić J. Agile digital transformation of System-of-Systems architecture models using Zachman framework. J Ind Inf Integr [Internet]. 2017;7:33–43. Available from: http://dx.doi.org/10.1016/j.jii.2017.03.001.

[31] Harkai A, Cinpoeru M, Buchmann RA. The "What" facet of the Zachman framework – A linked data-driven interpretation. Lect Notes Bus Inf Process. 2018;316:197–208.

[32] Dorohyl Y, Tsurkan V, Telenyk S, Doroha-Ivaniuk O. A comparison Enterprise Architecture framework for critical IT infrastructure design. Inf Tchnology Secur. 2017;5(2(9)):90–118.

[33] Nikpay F, Ahmad RB, Rouhani BD, Mahrin MN, Shamshirband S. An effective Enterprise Architecture Implementation Methodology. Inf Syst E-bus Manag. 2017;15(4):927–62.

[34] Mokone CB, Eyitayo OT, Masizana A. Decision Support Process for Selection of An Optimal Enterprise Architecture Framework For E-Government Implementation. J e-Government Stud Best Pract. 2019;2019:1–14.

[35] Lapalme J, Gerber A, Van Der Merwe A, Zachman J, Vries M De, Hinkelmann K. Exploring the future of enterprise architecture: A Zachman perspective. Comput Ind. 2016;79.

[36] Hadaya P, Leshob A, Matyas-balassy PMI. Enterprise architecture framework evaluation criteria : a literature review and artifact development. Serv Oriented Comput Appl. 2020;1–20.

[37] Rachmaniah M, Suroso AI, Syukur M, Hermadi I. Strategic Food Risks – Chili'S Agrosystem Perspective. J Manaj dan Agribisnis. 2021;18(1):19–31.

[38] Siregar JJ, Suroso AI. Big Data Analytics Based Model for Red Chili Agriculture in Indonesia. In: Lecture Notes on Data Engineering and Communications Technologies. Springer Science and Business Media Deutschland GmbH; 2021. p. 554–64.

[39] Suroso AI, Syukur M, Hermadi I, Rachmaniah M. Sistem Enterprise Komoditi Pangan Strategis. Bogor Indonesia: PT Penerbit IPB Press; 2022. 218 p.

[40] Wahyudi I, Suroso AI, Arifin B, Syarief R, Rusli MS. Multidimensional aspect of corporate entrepreneurship in family business and SMES: A systematic literature review. Economies. 2021;9(4):1–17.

[41] Maulana MM, Suroso AI. Designing a simple house of knowledge management. Digital Transformation Management. 2022. 107–126 p.