Proposed Enterprise Architecture Design For Agroforestry And Ecotourism Towards Industry 4.0

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**Abstract**

Management of forest resources can generate income for individuals or companies including agroforestry and ecotourism. In times of a pandemic like recent times, the application of technology with the Industry 4.0 framework is needed the most and is no longer a privilege. However, the implementation of Industry 4.0 technology requires large investment or cost so that a collaborative ecosystem is required from several stakeholders such as forest planter, crop planters, livestock and ecotourism business actors with suppliers, customers and policy makers. In its application, even for Information Technology (IT) system in general, the use of Enterprise Architecture is a mediator between business language and IT language. With all of that background and a literature study approach, this research will propose an Enterprise Architecture design with an Industry 4.0 framework in the agroforestry industry and ecotourism that can be used together to form an integrated ecosystem from various stakeholders, both for companies of various scales and small farmers if supported by the government or a larger company for better efficiency and common interests.

**Keywords** — Agroforestry, ecotourism, Forestry 4.0, Industri 4.0, Arsitektur Enterprise
1. INTRODUCTION

This paper focuses on the use of trees planted in the forest, utilizing the forest as crops and livestock farming and ecotourism. In developing Information Technology (IT) system to manage agroforestry and ecotourism business, an Enterprise Architecture (EA) is required as a bridge between business management and IT [1].

Industry 4.0 is a privilege because of the convenience and comfort usage of digital and automation systems utilizing advanced technologies. However, in the pandemic era it is essential for systems to have less human interaction, so Industry 4.0 technologies are essentials including to agroforestry. There are many technical researches referred to as Forestry 4.0 and a specific research paper is proposing a framework [2] as a holistic view. It is based on that Forestry 4.0 framework that the EA this paper is developed.

2. METHODOLOGY

The research starts with literature study from published journal papers, books, and articles. The first to study is understanding the business process. Then a framework is selected to be the basis of EA development. After EA being reviewed at a glance, processes from agroforestry and ecotourism business are examined to develop a proposed design of Business Architecture, paint the Business Canvas, Information Architecture and Technology Architecture.

2.1 Literature Review

The key words for literature study search are agroforestry, forestry, tourism, ecotourism business that’s related to forest management, tourism management, information technology, system design and development, supply chain, transformation, and architecture. Extended key words include Industry 4.0, enterprise resource planning (ERP), application programming interface (API). The papers consist of forestry and ecotourism from various countries. There are 111 articles, journal papers and books found in the literature study and 22 are selected for reference in this paper.

2.2 Enterprise Architecture Review

The EA frameworks used here is based on TOGAF [3] which is widely used framework for EA. Including being used to develop forest management support system [4].

2.3 Business Process Analysis

Knowledge of the industry business process is important in developing EA. This chapter describes the main activities for Agroforestry and Ecotourism based on the literature study.

2.3.1 Agroforestry Business

Agroforestry business produce wood and non-wood products. Main activities in managing wood products are Forest Management, Harvesting operation and Timber transportation. Forest Management includes inventory management, silviculture, plantation, pest and disease control, fire management, strategic planning and tactical and operational planning for commercials. Harvesting operation includes Harvesting planning and operation [5]. Wood or timber transportation, transportation planning and routing [6] and loading / unloading activities. [1] Wood product business value chain is complex and consists of many interdependent companies. The flow starts from harvesting area that produces logs for saw mills and pulp mills supplying paper mills. Chips produced in saw mills can be purchased by pulp mills as raw materials also. Biomass from harvest area as well as organic residues from saw mills is supplied to panel mills and pellet mills which then produce panels and pellets respectively supplying the merchant for the market for panels and engineered products and energy. Saw mills also produces lumber for this market. Value-added converting plants products from paper, saw and panel mills as well.

Agroforestry's non-wood products processing livestock and crops for meat and horticulture sectors also called Agri-food supply chain (AFSC). Main actors are Industrial partners and Research institutes for Farmers / producers, Logistics and 3PL partners, warehousing and packaging, Agricultural cooperatives, Manufacturers / processors, wholesalers, retailers and consumers. [7] Main activities for crops based
AFSC from [8] are Breeding, Producing Seeds & Plants, Cultivating & Harvesting, Transportation for both Fresh products and Processed products, Distributing and consuming. Fresh products have Post-harvesting before Distributing while Processed products requires Pre-processing, Transport and Processing.

2.3.2 Ecotourism Business

Tourism supply chain consists of many business actors and covers Travel packages, Travel, Hotels and Restaurants industry. The network of business actors are Tour marketing and sales, Travel agents, Transportation, Accommodation, Catering F & B, Ground operations, Tour operators and guides, Cultural, social and excursion events, Furniture and Crafts, Infrastructure, services resources, Energy and Water supply, Waste recycling and disposal, Food production, Laundry, Customers /Tourists. [9] Tourism industry has higher adoption level of Industry 4.0 technologies. Almost all of the business actors are already involved using online transactions. The technology adoption depends on infrastructure covering the area.

2.4 Forestry 4.0 Framework

Advances gain by adopting Industry 4.0 to agriculture and agriforestry [10] including geospatial database development to enhance forest inventory and technology application of the IoT, Lidar, unmanned aerial vehicle (UAV), Big Data management, real-time communication systems, digitalization of mechanization automation, machine learning and AI, advanced decision support system that leads to Forestry 4.0 framework [1]. This paper will be based on this framework to develop the EA.

Information exchange between systems and equipment and between organizations is necessary. Standards are implemented for connectivity to avoid complication. There are standardization initiatives [11] since early 2000 including connectivity to other industries. All these standards are XML based limited in the specification of messaging, envelope and security.

3. PROPOSED EA DESIGN

In this chapter onwards each of proposed Business architecture, business canvas, application architecture and information system architecture will be explained.

3.1 Business Architecture

The core process in Agroforestry and ecotourism process are Tree farming, Crop farming, Livestock farming and Ecotourism. The suppliers and partners are the contractors for silviculture and harvesting of tree farming and crop farming, suppliers of fertilizers and chemicals, livestock fodder, crop plant nursery, amenities for accommodation and facilities, energy supplier, travel agents or any online marketing agent or endorsement, banks and financial institutions for investment, cashflow and customer online payment and IT services.

Supporting resources are common to all organizations and not only for Agroforestry and ecotourism. Some organization may use services from outsource company. Owners and executives are the governance of the organization or networked of business units and or companies. The main function is to govern and manage. Customers including mills, distributors, transportation company, direct customer of crops and livestocks as well as tourist. The relationships between core process with suppliers, customers, and supporting resource in Agroforestry and Ecotourism industry is show in figure 1.
3.2. Business Canvas

Business model canvas shown in figure 2 provides one page understanding that represent the whole business model that contain nine building blocks and explained below. Although in the proposed collaboration architecture the actor of business process may involved business units, smaller company or network of companies, the overall business view is still the same.

![Business Model Canvas](chart.png)

Figure 1. The Relationships Between Core Process With Suppliers, Customers, and Supporting Resource in Agroforestry and Ecotourism Industry.

Figure 2. Business Model Canvas for Agroforestry and Ecotourism Industry.
1. **Value Proposition**

The value proposition are: Quality product supply produced in time and according to order quantity to the mills, Quality Crops and Animal Farm product supply to distributors, delivered in time and in the right quantity. Convenience and transparency in operations and product delivery, Integrated system for Partners, Customers, Workers and Shareholders for efficiency and comfort.

2. **Customer Segments**

Saw Mills and in collaborative framework including panel and pellet mills, Pulp Mills including paper and other value-added manufacturers, Crops and Animal Farms Distributors and direct customers and Tourists are the customer segments.

3. **Channel**

The channel includes Online Application for Product Purchase Order, Online Application for Order to Supplier with Delivery Process tracking, Customer Relationship Management application for after sales.

4. **Customer Relationship**

Including in Customer Relationship are Online Customer Relationship Application, claim resolution, customer service, chatbot, Order processing Tracking for Crops and Animal Farm products, Online Booking and Self-service for visiting Tourists.

5. **Revenue Stream**

Selling of Timber for saw mills and pulp mills, Crops products from agriculture, Animal farm products, Eco-Tourism for leisure and community or private events are Revenue streams in the business.

6. **Key Partners**

Key partners are Operational Contractors, Plantation, Harvesting Contractors, Facility maintenance Contractors, Material Producer / Supplier for Tree maintenance including Fertilizer & Chemicals, Animal Farm fodder also for Amenities for hotel and facilities, Plantation and tourism workers, Energy Supplier, Travel Agent, Financial Institutions, Banks, IT Services company.

3.3. **Application Architecture**

Architecture components and the application for each component is explained below and shown on figure 3. All these applications must be able to be integrated with other applications internally or to external organizations using API interface.

![Figure 3. Application architecture for for Agroforestry and Ecotourism industry.](image-url)
1. Application for core process
   - Enterprise Resource Planning (ERP) System
     ERP system is proposed for this function because it is already completed, integrated and utilized for all internal and external transactions. ERP could not cover all the business process therefore other systems are also required. ERP manages people, process and technology and integrate processes in Sales, Production with Purchasing [12]. Currently ERP technology is already matured. Various ERP architecture, ERP Software as a service (SaaS) package is explain in [13] [14].
   - Geospatial Planning System
     GIS system is essential for forest inventory management either done manually using sampling or using remote sensing like satellite and UAV using optical or LiDar. [15] [16] Remote sensing is also beneficial for forest protection and monitoring from illegal logging, hot spot or fire spot, forest or tree modelling and object detection. GIS is also available as SaaS. Blockchain, IoT and RFID technologies used for integration. [17][18]
   - Operation to Information Technology
     IoT Platform, IoT, sensors and other cyber physical system in manufacturing is referred to as automation control system called Operational Technology (OT). OT focus is more on production and machine control and monitoring useful for predictive maintenance and error prediction. Current issues lingering convergence of OT and IT is ybersecurity. [19] [20] [21]
   - Tourism Intelligent Building and Facilities System

2. Owners and Executives
   - Dashboard for Tree Farm Crop &Livestock Farm Operational, Order Delivery, CRM Dashboard and Ecotourism Facility Dashboard

3. Application for Customers
   - Online Customer Relationship Management, Online Store for Crop & Livestock Farm Product, Delivery Monitoring, and Online Booking and Self-Service for Eco-Tourism

4. Application for Suppliers / Partners
   - Online Supplier Order for Materials and Services, Travel Agent Integration and Financial Institutions and Bank Interface

5. Application for Supporting Resources

3.4. Information Architecture
   Figure 4 shows the databases required for Information Architecture of Agroforestry and ecotourism industry divided by each category.

3.5. Technology Architecture
   Technology architecture based on data, application and business architecture is show in figure 5 with hardware connectivity in figure 6. The whole architecture categorized by Business, Application, Data and Technology architecture is shown in figure 7 and simplified EA in figure 8.
**Figure 4. Technology Architecture: Master and Transactional Databases**

**Figure 5. Technology Architecture: Hardware Connectivity**
5. CONCLUSION

EA is useful to define a complex Agroforestry and Ecotourism system. It relates business with IT application, data and technology. Challenges have been to provide connectivity to the forest locations where workers and equipment work.

6. SUGGESTION

This proposed EA is suitable for agrobusiness and ecotourism industry toward Industry 4.0. It is suggested for a collaborative EA especially for ERP and GIS implementation that are risky and costly. The suggested collaboration between companies, organizations, small and large farmers or business...
actors and regulation maker meaning larger enterprise or government to provide services for smaller farmers, suppliers and distributors. Future research is to study the EA implementation and the applied technology and method.

REFERENCES


