# PROJECT PROPOSAL FOR RESEARCH PROJECT

# IIT 474-6

# Development of New Supply Chain Models and Ontologies:

A study of Sri Lankan minor export crops - Cinnamon, Turmeric & Ginger


**Dilrukshika T. A. G** **UWU/IIT/17/012**

*Industrial Information Technology*

**Jayalath S. H. M. M** **UWU/IIT/17/020**

*Industrial Information Technology*

**Nawanjani S. K** **UWU/IIT/17/037**

*Industrial Information Technology*

**Department of Computer Science and Informatics**

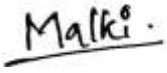
**Uva Wellassa University**


**November 2021**

## Project Title

Development of New Supply Chain Models and Ontologies: A study of Sri Lankan minor export crops - cinnamon, turmeric & ginger

## Student Details

| Name Registration | Number | Contact | Signature |
|---|---|---|---|
| Dilrukshika T. A. G | UWU/IIT/17/012 | iit17012@std.uwu.ac.lk<br>0719631032 |  |
| Jayalath S. H. M. M | UWU/IIT/17/020 | iit17020@std.uwu.ac.lk<br>0773968134 |  |
| Nawanjani S. K | UWU/IIT/17/037 | iit17037@std.uwu.ac.lk<br>0767592427 |  |

## Supervisors Details

**Principle supervisor**

| **Name** | **Email** | **Contact No** |
|---|---|---|
| Mr. N.E.C. Jayasekara | chinthaka@uwu.ac.lk | 0718194439 |

Signature: ……..  Date: 28/11/2021

# Contents



# List of Figures



# List of Tables

# 1. Introduction

## 1.1 Background of the study

Traditional minor export crops supply chains in Sri Lanka that engage in moving spices from the producer to the consumer are prone to various sources of inefficiencies. Farmers in spice producing areas are unable to attract competitive buyers.

Demand and Production of turmeric, ginger and cinnamon had increased during the last two years and they were stable during the last years to present. Nearly 50 percent of the production of turmeric and ginger comes from Kurunegala, Kandy, Gampaha and Kegalle districts. And cinnamon comes from Kandy, Matale, Belihull Oya, Haputale, Horton planes, Negombo, Matara, Kalutara and Rathnapura areas. The demand for turmeric, ginger and cinnamon has increased in the country and the prices have also increased.

Sri Lankan minor export crops are demanded from worldwide.

| Description | 2017 | | 2018 | | 2019 (January To November) | |
|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value |
| Cinnamon | 16,617,089 Kg | 202,205 | 17,536,573 Kg | 213,249 | 15,576,225 Kg | 160,195 |
| Pepper | 13,309,191 Kg | 83,497 | 13,118,114 Kg | 74,283 | 7,392,365 Kg | 44,226 |
| Cloves | 7,805,600 Kg | 47,140 | 3,279,577 Kg | 16,031 | 4,821,048 Kg | 29,067 |
| Essential Oils | 619,060 Kg | 28,046 | 619,078 Kg | 24,520 | 599,855 Kg | 21,703 |
| Nutmeg & Mace | 2,042,871 Kg | 14,389 | 1,938,368 Kg | 13,858 | 2,874,813 Kg | 20,256 |
| Oleoresins | 382,347 Kg | 17,992 | 360,125 Kg | 12,839 | 335,964 Kg | 12,462 |
| Other Spices and Spice Mixtures | 880,737 Kg | 3,759 | 813,571 Kg | 3,135 | 741,430 Kg | 2,989 |
| Turmeric (Curcuma) | 114,896 Kg | 675 | 76,376 Kg | 628 | 108,598 Kg | 546 |
| Ginger | 81,606 Kg | 615 | 97,179 Kg | 756 | 32,601 Kg | 274 |
| Cardamoms | 839,294 Kg | 5,720 | 108,307 Kg | 992 | 12,704 Kg | 183 |
| Vanilla | 5,995 Kg | 178 | 1,555 Kg | 360 | 701 Kg | 136 |
| Saffron | 10,894 Kg | 62 | 6,432 Kg | 29 | 18,505 Kg | 106 |
| Condiments | 1,271,375 Kg | 3,894 | 202,430 Kg | 418 | 39,183 Kg | 90 |
| **Total :** | **43,980,955** | **408,173** | **38,157,685** | **361,100** | **32,553,992** | **292,233** |

**Figure 1: Minor Export Crops**

Supply chain management (SCM) implies managing the relationships between the businesses responsible for the efficient production and supply of products from the farm level to the consumers to meet consumers' requirements reliably in terms of quantity, quality and price. In practice, this often includes the management of both horizontal and vertical alliances and the relationships and processes between firms. Agri-supply chains are economic systems which distribute benefits and apportion risks among participants. Thus, supply chains enforce internal mechanisms and develop chain wide incentives for assuring the timely performance of production and delivery commitments. They are linked and interconnected by virtue of shared information and reciprocal scheduling, product quality assurances and transaction volume commitments. Process linkages add value to agricultural products and require individual participants to coordinate their activities as a continuous improvement process. Costs incurred in one link in the chain are determined in significant measure by actions taken or not taken at other

links in the chain. Extensive pre-planning and co-ordination are required up and down the entire chain to affect key control processes such as forecasting, purchase scheduling, production and processing programming, sales promotion, and new market and product launches etc.

Following are the components of an organized supply chain:

- Procurement or sourcing
- Logistic management - Transportation, Material management, Warehousing and Logistics Network modeling
- Organizational management - Long term storage, Packaging technology, Cold chain management, Energy efficient transport and Quality and safety

## Literature Review

According to prior studies we identified the gaps between theory and practices in order to develop a supply chain model for a particular crop including Turmeric, Cinnamon and Ginger.

### Supply Chain Management

Supply chain management is described as the integrated planning, coordination, and control of all processes and activities throughout the supply chain in order to offer a value added service while lowering the overall cost of all supply chain stakeholders (Van Der Vorst et al., 2000)**.** It has been suggested that the supply chain management field lacks appropriate theoretical basis, leading in simplified conceptualizations of supply networks and their settings, and that theory may be useful in unearthing some of the complexity that characterizes supply chains (Dubois et al., 2004)**.** The supply chain management idea often focuses on reorganizing the supply chain to increase material and information flow efficiency and effectiveness(Alvarado & Kotzab, 2001)**.** Supply chain management has grown more crucial in a globalized corporate environment as the focus has shifted from individual cost savings to overall revenue growth and performance(Chandra, C. and Kumar, 2000)**.** Many manufacturing and service companies throughout the world have discovered that shifting costs to other supply chain partners in upstream or downstream nodal points does not improve the focal firm's competitive advantage (Harland, 1996)**.**

### The SCOR model

Users can utilize the SCOR Model to address, enhance, and communicate supply chain management practices inside and across all relevant stakeholders. The SCOR framework tries to include components of business process design, best practices, and benchmarking into one framework. The SCOR Model was created to describe the business activities involved in meeting

a customer's demand at all stages. Using a standard set of concepts, it may be used to define and enhance both small and complicated supply chains(Peter Bolstorff, 2011). Farm produce logistics are characterized by a wide variety, big quantity, relative independence, consumable and value-added processing, and significant digitalization in modern agriculture. The SCOR model (Supply-Chain Operations Reference-model) of agricultural products based on the Internet of Things has been proposed through the improvement of the logistics model of traditional agricultural products, taking into account the features of modern agriculture and farm produce logistics(Lianguang, 2014).

Turmeric, Cinnamon and Ginger are small-scale, non-traditional minor crops.

**Cinnamon**

There are eight cinnamon species in Sri Lanka but among them only one species is grown commercially. Although Sri Lanka is one of the leading exporters of cinnamon in the world, the growth of the cinnamon industry is slow due to supply chain risk factors (Sugathadasa et al., 2021). The cinnamon supply network in Sri Lanka is not properly optimized and it has influenced many inefficiencies and risks in the cinnamon SCM. The researches which have been done previously have identified certain risks in this supply chain. Five critical risk factors were identified related to quality control, communication, timing of product delivery, inventory, and lack of technology which demands immediate mitigation strategies (Sugathadasa et al., 2021). Providing an ample solution to overcome the risks in cinnamon SCM is one of the objectives of this research.

**Ginger**

In the ancient times ginger has been widely used as a medicine in Chinese and Ayurveda medicine but in recent years, Ginger has been cultivated as a commercial crop in Sri Lanka. There are many local and introduced varieties of Ginger grown in Sri Lanka such as local ginger, Chinese ginger and Rangoon ginger. The supply chain of Ginger can have several problems due to the actors of that supply chain. Wimalaratana(2018) has mentioned the price fluctuations, unavailability of quality seeds, scarcity and high prices of fertilizer and other inputs, and inefficient extension services as the major issues in the ginger market of Sri Lanka. These issues can arise due to the lack of a proper SCM in the Sri Lankan context at present.

**Turmeric**

Turmeric is a highly valued crop due to the wide-range of uses it has in various industries. Turmeric is one of the multi-use commodities, which has commercial, economic, cultural and medicinal significance across the globe (Abeynayaka et al., 2020). In Sri Lanka, the turmeric production is concentrated in the intermediate and wet zones. The main issue of the turmeric market is the inefficiency of turmeric production and it has led to Production instability in turmeric production over the years. This inefficiency is inseparable from the constraints that

occur in managing turmeric farming that are linked to the aspects like input availability, production technology, market price and the delivery of necessary support services (Apasinghe, 2013) This implies the need of a good SCM in the turmeric production as well.

## 1.2 Problem Definition

Currently, it is critical to achieve competitive advantage of sustainable supply chain management in Sri Lanka. The important areas that have a strong impact on sustainable Supply Chain Managements are risk, uncertainty, strategy, innovation, relationship, infrastructure, regulation and technology. These factors have been studied within the manufacturing sector in developed countries; there is a lack of research on Agri-supply chains in Sri Lanka with respect to the concept of sustainable Supply Chain Management.

Therefore, our research tries to map the supply chain and identify the influencing factors and their performance on sustainable Supply Chain Management in the turmeric, cinnamon and ginger crops supply chain in Sri Lanka. Importantly, early research suggests that mapping the supply chain represents a significant research gap not only in Agri-supply chains but also supply networks in general.

**Significance of the study:**

Individual suppliers, producers and marketers who are associated through a supply chain coordinate their value creating activities with one another and, in the process, create greater value than they can, when they operate independently. The Sustainable supply chains create synergies in one of three ways:

- Expand traditional markets beyond their original boundaries and thus increase sales volume for members
- Reduce the delivered cost of products below the cost of competing chains and thus increase the gross margin for the working capital committed by members of the chain
- Target specific market segments with specific products and differentiate the service, product quality or brand reputation of the products delivered to these market segments and thus increase consumer perception of delivered value.

## 1.3 Project aims/objectives

**Our primary aim is to,** Develop supply chain models for each selected crops - Turmeric, Cinnamon and Ginger.

The objectives are,

1. To find out the factors that can be automated in the developed models.
2. To develop a design guideline for the software / system developers in relevant fields.
3. To Develop separate ontologies for each developed model.

## 2. Project Description

A supply chain is considered as a loop from customers' demand to customer's satisfaction by final product or service. It consists of a chain of producers, suppliers, distributors, and transporters. A supply chain can be modeled as a system of intelligent agents, which agree to cooperate to reach the final goal. A new, modern, and cost-effective implementation of supply chain management (SCM) is enabled by rapidly developing information and communication technologies(Jayaratne et al., 2011).

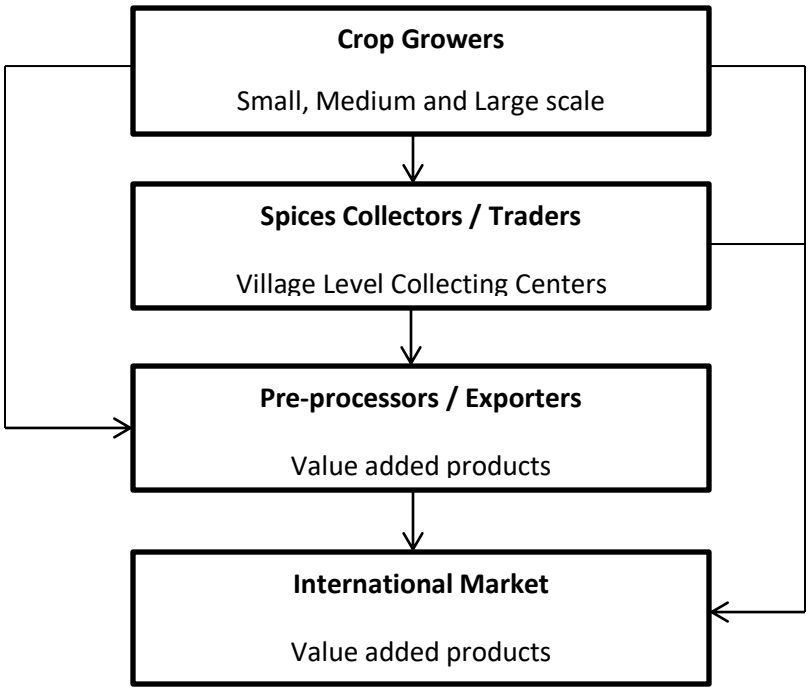



**Figure 2: Crop supply chain Structure**

There are three main objectives for achieve the final outcome in our proposed project. First we develop a supply chin model for a particular crop such as:

- Supply chain model for Turmeric crop
- Supply chain model for Cinnamon crop
- Supply chain model for Ginger crop

For this we are going to use the SCORE model.

Then we are going to find out the factors of separate model to automate. Then using responsibility assignment Metrix we can bring prepared models in to computer platform.

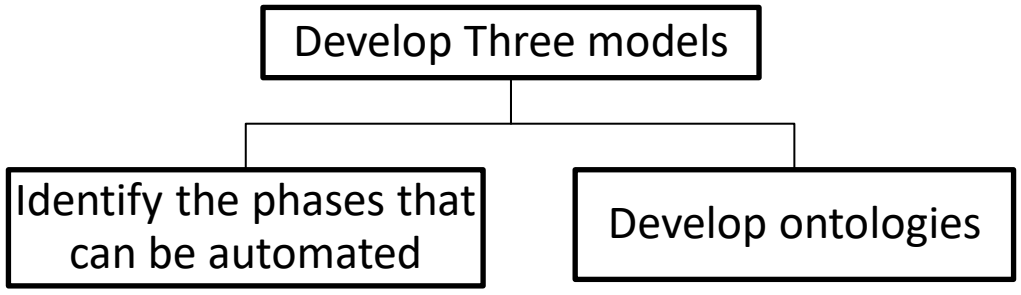
As well as by using Responsibility Assignment Metrix, we supposed to consider who are the actors and how they accountable for each and every step they involve.

Thus our plan is to develop a design guideline for the people who are developing software/ Systems in the relevant field.

As final objective we are going to develop ontology for separate models using protégé tool.

## 3. Methodology

The supply chain management ontology has the goal of providing a framework to better formulate, understand, analyze and share a company's supply chain management model. Therefore ontologies can be regarded as precious tools that can be used to increase the efficiency of supply-chains.




.

**Figure 3: Methodology**

The methodology used for constructing a general-purpose ontology for supply chain management is presented along with the resulting ontology and an ontology based SCM model. The ontology may be enhanced by including supply chain performance drivers and by including other concepts such as forecasting, warehouse location, aggregate planning, etc. More effort can be devoted to synchronizing the ontology with the SCOR (Supply Chain Operations) model in which the operations of supply chain is classified as plan, source, make, deliver and return, as is used in our ontology.

**SCOR Model**

SCOR focuses on the measurement and assessment of the outcomes of supply chain process execution. A comprehensive approach to understanding, evaluating, and diagnosing supply chain performance consists of three elements: Performance Attributes, Metrics, and Process / Practice Maturity. Elements, as distinct from the Levels in the Process and Metrics hierarchies, describe different aspects or dimensions of performance.

- Plan - develop strategies for managing resources and balancing demands and supplies. A set of metrics to monitor the SC efficiency has to be proposed.
- Source - choose a set of suppliers for producing goods and services.
- Make - goods and materials are transformed to final products. This step is the manufacturing portion of the supply chain. Production scheduling, testing, packaging, etc. are the activities that take place at this step.
- Deliver - coordination of orders from customers, developing a network of warehouses, distribution and transportation of products to customer, invoicing system to receive payments from customers. This part is known as “logistics”
- Return - deals with the problematic of defective products, how they can be returned to producer and how customers are dealt with to satisfy their requirements on problematic products.

**Responsibility Assignment Matrix**

The responsibility assignment matrix is a project management style with four main roles: responsible, accountable, consulted and informed (this is also referred to as a RACI matrix). Each letter applies to a member of the team and lets them know what their role is in the project and how it fits in with the other members of the team.

The RAM method of project management allows team members to understand why the tasks they’re doing are important in the big picture. When a project manager decides to implement the responsibility assignment matrix on a big project, they should make sure that everything has dates and reminders for every party. Informed team members should know when they’re going to get updates from responsible team members. By the same token, a consulted team member should have an idea of when they’re going to get questions from responsible team members.

Finally, the accountable team member will have assigned out all of the tasks and follow up on any missed deadlines.

**Protégé**

Protégé is a free, open-source ontology editor and framework for building intelligent systems. Protégé's plug-in architecture can be adapted to build both simple and complex ontology-based applications. Developers can integrate the output of Protégé with rule systems or other problem solvers to construct a wide range of intelligent systems. Protégé is based on Java, is extensible, and provides a plug-and-play environment that makes it a flexible base for rapid prototyping and application development. Protégé fully supports the latest OWL 2 Web Ontology Language and RDF specifications from the World Wide Web Consortium.

## 4. Resources Needed

**Hardware:**

- Computers /laptops,
- Mobile phones,
- Wi-Fi adapters

**Software:**

- Protégé

**Technologies**

- Ontology development technology

## 5. Individual Contribution

| Name / Index number | Contribution |
|---|---|
| **Dilrukshika T.A.G**<br><br>**UWU/IIT/17/012** | **Develop a supply chain model for Turmeric crop**<br>• Find out the factors of Turmeric crop to automate using the Responsibility Assignment Matrix.<br>• Develop a design guideline<br>• Develop an ontology for developed model (supply chain model for Turmeric crop) using protégé tool |
| **Jayalath S.H.M.M**<br><br>**UWU/IIT/17/020** | **Develop a supply chain model for Cinnamon crop**<br>• Find out the factors of Cinnamon crop to automate using the Responsibility Assignment Matrix.<br>• Develop a design guideline<br>• Develop an ontology for developed model (supply chain model for Cinnamon crop) using protégé tool |
| **Navanjani S.K**<br><br>**UWU/IIT/17/037** | **Develop a supply chain model for Ginger crop**<br>• Find out the factors of Ginger crop to automate using the Responsibility Assignment Matrix.<br>• Develop a design guideline<br>• Develop an ontology for developed model (supply chain model for Ginger crop) using protégé tool |

**Table 1: Contribution**

## 6. Time Plan

| Tasks | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep |
| Identify research area | | | | | | | | | | | | |
| Formulate research question and planning work | | | | | | | | | | | | |
| Conducting literature review | | | | | | | | | | | | |
| Collecting required data | | | | | | | | | | | | |
| Preparation of research proposal | | | | | | | | | | | | |
| Proposal presentation | | | | | | | | | | | | |
| Develop a supply chain model for crop | | | | | | | | | | | | |
| Find out the factors of crop to automate using the Responsibility Assignment Matrix | | | | | | | | | | | | |
| Develop separate ontologies for developed models using protégé tool | | | | | | | | | | | | |
| Thesis writing and Final presentation | | | | | | | | | | | | |

**Table 2: Time Plan**

## 7. References


Abeynayaka, A. A. S. L., Bandara, A. M. K. R., Lankapura, A. I. Y., & Idamekorala, P. R. (2020). Economics of Turmeric Production in Sri Lanka: An Empirical Analysis in Major Turmeric Growing Districts. *Asian Journal of Agricultural and Horticultural Research*, *6*(4), 10–17. https://doi.org/10.9734/ajahr/2020/v6i430078

Alvarado, U. Y., & Kotzab, H. (2001). Supply Chain Management: The Integration of Logistics in Marketing. *Industrial Marketing Management*, *30*(2), 183–198. https://doi.org/10.1016/S0019-8501(00)00142-5

Apasinghe, S. (2013). විවෘත වෙළෙඳ ප්‍රතිපත්තියේ බලපෑම නිසා දේශීය අර්තාපල් ගොවියාගේ ආර්ථික හා සාමාජීය තත්ත්වය කෙරෙහි හා යෙදවුම් බෙදාහැරීමේ පද්ධතිය තුළ සිදු වී ඇති විචලනා පිළිබඳ අධ්‍යයනයක්. *(Doctoral Dissertation)*.

Chandra, C. and Kumar, S. (2000). Supply chain management in theory and practice: a passing fad or a fundamental change? *Industrial Management & Data Systems*, *Vol. 100 N*, 100–114. https://doi.org/10.1108/02635570010286168

Dubois, A., Hulthén, K., & Pedersen, A. C. (2004). Supply chains and interdependence: a theoretical analysis. *Journal of Purchasing and Supply Management*, *10*(1), 3–9. https://doi.org/10.1016/J.PURSUP.2003.11.003

Harland, C. (1996). Supply network strategies the case of health supplies. *European Journal of Purchasing & Supply Management*, *2*(4), 183–192. https://doi.org/10.1016/S0969-7012(96)00014-7

Jayaratne, P., Styger, L., & Perera, N. (2011). Sustainable supply chain management: using the Sri Lankan tea industry as a pilot study. *25th Annual Australia New Zealand Academy of Management Conference (ANZAM 2011)*, *1*(December 2018), 1–22. http://ro.uow.edu.au/gsbpapers/179

Lianguang, M. (2014). Study on Supply-Chain of Agricultural Products Based on IOT. In *2014 Sixth International Conference on Measuring Technology and Mechatronics Automation*. IEEE. https://doi.org/10.1109/ICMTMA.2014.153

Peter Bolstorff, R. R. (2011). *Using SCOR to Drive Supply Chain Improvement* (Issue Chapter 1). AMACOM. https://learning.oreilly.com/library/view/supply-chain-excellence/9780814417713/

Sugathadasa, P. T. R. S., Perera, H. N., Hewage, H. C., & Samarakoon, S. P. A. V. S. (2021). Identifying the Supply Chain Risk Factors in Cinnamon Export Industry in Sri Lanka. *Sri Lankan Journal of Agriculture and Ecosystems*, *3*(1), 81. https://doi.org/10.4038/sljae.v3i1.62

Van Der Vorst, J. G. A. J., Beulens, A. J. M., & Van Beek, P. (2000). Modelling and simulating multi-echelon food systems. *European Journal of Operational Research*, *122*(2), 354–366. https://doi.org/10.1016/S0377-2217(99)00238-6

Wimalaratana, W. (2018). Challenges and Prospects of Ginger Farming in Sri Lanka With Special Reference To Plogahawela Divisional Sectratariat Division. *International Journal of Business, Economics and Law*, *17*(3), 63–69.