

SUPPLY CHAIN DESIGN FOR THE AGRICULTURAL PRODUCTS IN VIETNAM: A CASE STUDY OF SIM WINE IN KON TUM PROVINCE

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Abstract. According to cultural diversity and wide-variety of natural resources, especially, people who lived in highlands areas of Viet Nam has long been produced many feature products. However, the current chain for kind of products are limited that affect the profit of producers. In the research, as a case study of Sim wine which made from Sim fruit (*Rhodomyrtus tomentosa*) in Kon Tum province, Central Highlands in Vietnam, is a potential product that have a special taste of alcoholic beverage with the scent of flower and natural healing properties related to reduce joint pain, prevent cancer, anti-aging and so on. Meanwhile, this product is facing various problems of production activities, demand fluctuation, wine markets consumption and inefficient network designed. By this case, the paper aims to propose an adequate supply chain for Sim wine by generating factory design, facility planning and logistic systems from suppliers to the end consumers. To sum up, the improvement in this research help to increase and develop the competitive scenario of Sim wine in domestic and global markets.

Keywords: Supply Chain Network Design, Wine supply chain, Facilities planning, Global wine market, Wine value chain

1. INTRODUCTION

Located in the tropical zone contains lowlands, hills, and densely forested highlands, Vietnam has cultural diversity and wide-variety of natural resources from the northern to southern areas. There are many well-known agricultural and manufactured products such as rice, dragon fruit or Basa fish, DaLat wine and others. By the way, the country which takes the advantages of developing food supply chain inherited old-aged

agricultural tradition in domestic or foreign market.

This study aims a case study of Vietnam Sim wine, which have great flavor and high quality made from special fruit only growing in highland. Furthermore, the wine not only has taste like fermented blackcurrant alcoholic beverage but also has natural healing properties for human with drinking a suitable amount. According to the official website of Kon Tum government, it has total area of 17,000 ha (2015) of Sim forest

which produced more than 10,000 wine bottles in 2015 and has long been bringing a big profit for the producers.

However, Sim wine was only existing in market few recent years lead to face many challenges contain how to adapt demand in market or the used of Sim fruit and manufacturing Ssim wine inefficiency.

The contribution of this paper includes the potential market analysis to increased production, consumption as well as the awareness of customers for sim wine. Moreover, the research focused on designing the Kon Plong supply chain which will be effective for operating the network of facilities and distribution options. Indeed, proposing new products combine with inventory policy are also concerned.

2. LITERATURE REVIEW

With the information from the Australian Wine Research Institute (AWI) Report, the benefits of wine to human health for regular and moderate wine consumption. In the same, Guilford and Pezzuto (2011) have clinical studies with animal models shown that wine may protect against cardiovascular disease, certain types of cancer, type 2 diabetes, neurological disorders and others. The phytochemical compound of fruit making wine have special properties bringing benefit for human health. Indeed, based on the official website of Kon Plong district- Vietnam, Sim fruit have the same features for producing wine.

Garcia and Marchetta (2011) have published “A framework for measuring logistics performance in the wine industry”, proposed that a logistics benchmarking framework for the wine industry. A case study of Argentina, they illustrate the role for adapting continuously in their logistics processes and implementing the industry best practice. Furthermore, wine companies should realize logistic activities and the impact of performance on the business in order to compete for existent and new markets.

According to “Operations Management: Creating Value along the Supply Chain”, Russell and Taylor (2011) have preferred “New products and services are the lifeblood of an organization” The effect of product design on the market in a business and that cause to be managed effectively. Technology decision is another step that influence the cost, speed, quality, and flexibility of operations. Moreover, it decide the capacity of the firm through whole system and interaction each other. Depending on the situation, decision maker need to have a strategy for the most appropriate and the most efficient choice in both aspect.

France is as well-known in wine sector over the world about making wine and traditional production for long time. In study of Montaigne and Coelho (2012), the wine filiere is to analysis with four complementary and recent approaches include the innovation chains, the global value chain (GVC) and the theory of transaction costs and the marketing approach. Then, it conduct to analyze the main actors of value chain in whole system such as: the grape growers, co-operatives, wine brokers, wine merchants and clusters.

According to a book of Tompkins, “Facility planning”, facility planning has significant functions not only a science but also a strategy which include a wide concept related to location, facility system, layout and material handling. In order to have a good planning as reduce 30 percent the operation, facility planning give the way to determine the best support production.

Francis (1992) introduced three main types of layout: product layout, process layout and group layout. In particular, the process layout is grouped machine having the same operation. Also, it is always considered as minimizing the flow distance among the group. In this type of layout, the product’s variety is high but the product’s volume is low.

“The Son Tra (*Docynia Indica*) value chain and market

analysis” report, made by Hoang Thi Lua, Ann Degrande and Delia Catacutan from Australian Center for International Agricultural Research, focused on improve the performance and increase productivity for Son tra plant in North-West Vietnam. Because of potential economic value product, Son tra was suggest as a target species for promotion in this area by producing many products such as Son tra wine, Son tra Juice and Dried Son tra. However, this fruit is faced several difficulties contain poor plantation management, harvesting technique and the lack of knowledge on processing. As a result, this study aims to develop operation system by managing the natural resources at provincial level combine with expanding the production capacity at household level, developing farmers ‘skills about commercial activities such as marketing research or distribution, and applying high technology in production aspects.

3. WINE PRODUCTION AND MARKET ANALYSIS

3.1 World wine status

According to International Organization of Vine and Wine (OIV) shows some of these changes in 1999 - 2015 periods. The world of wine related to production and consumption is changing slowly combine with shifted from “traditional” countries to “new” wine countries. There were totally 60 wine-producing countries which had highly concentrated production.

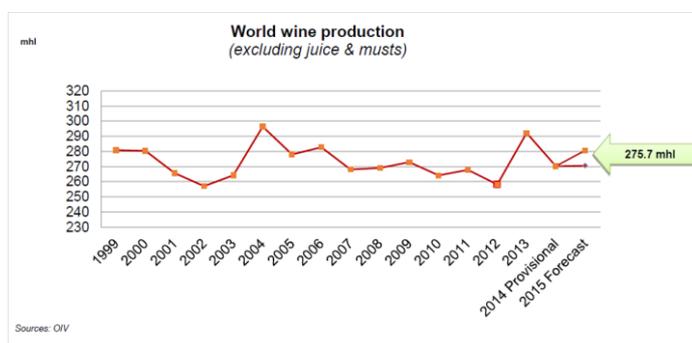


Figure 1: World wine production (1999-2015)

Source: International Organization of Vine and Wine (OIV)

In general, the graph shows the changes and a decline overall in wine production. At the beginning of this period, the volume was under 289 million hectoliters (mhl). However, the peak production was nearly 300 mhl in 2004. This higher production did not last long, there were several fluctuations until late 2004 when there was a sudden decrease from 300 mhl to 260 mhl. Meanwhile, it fell before rising strongly again in 2013. Through the end of the year, there was a sharp downward trend which has 270 provisional volume in 2014. After that the forecast for wine production in 2015 recovered approximately 275mhl.

According to Trade Data and Analysis (TDA), world wine consumption was fluctuated from 2011 to 2015. Generally, over 240 million hectoliters of wine was produced globally, with 248 million hectoliters in 2015. By comparison, the quantity of wine selling in market (247 million hectoliters in 2014) was slightly different with having 242 wine-consuming countries. The top five wine producers in the world are United States, France, Italy, Germany and China respectively.

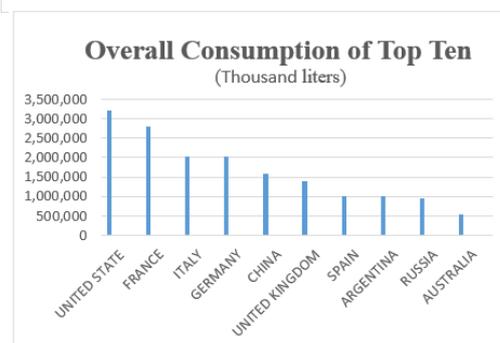
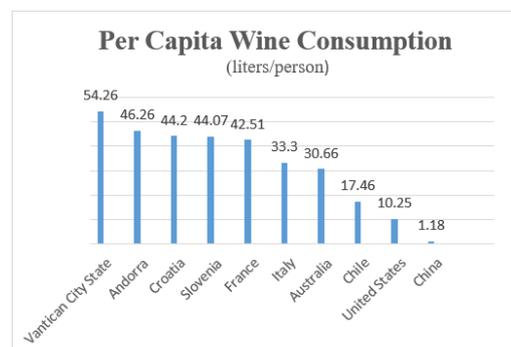


Figure 3: Overall consumption of top ten
 Source: TDA

Per capita consumption can provide a first glimpse into the temperaments of the demand side of the global wine industry. There are many factors that affect to the amount of consumption between countries related to economic, geographic and cultural reasons. In 2015, the nation with the highest rate of consumption was Vatican City State, at 54.26 liters per person per year. The wine production giants in Europe, France and Italy are ranking 5nd and 6rd followed closely behind at 42.51 and 33.3 liters respectively that having the 2nd and 3rd position of overall consumption. The United States has the highest volume for global consumption, with 3,270 million liters (10.25 liters per capita). Although China consumes close behind at 1.18 liters per person per year, they are ranked 5th in the world for overall consumption and have been steadily rising since the early 1990s. In conclusion, using per capita consumption can act as a good proxy for determining how much a particular culture “enjoys” drinking wine.

3.2 Vietnam Wine market

Based on Wine Institute Wine American report in California, Vietnam is a traditional Asian country that discovers wine, predominantly male consumers tend to preferred, tannic and powerful wines with high levels of alcohol. The best-selling wine are reds (65%) followed by whites (25%) and finally sparkling wines (10%). The Vietnamese wine market was estimated more than 25 million liters in 2016. Most wines, especially premium ones, were imported and the consumption is set to increase sharply in future in a market considered the most promising in Asia.

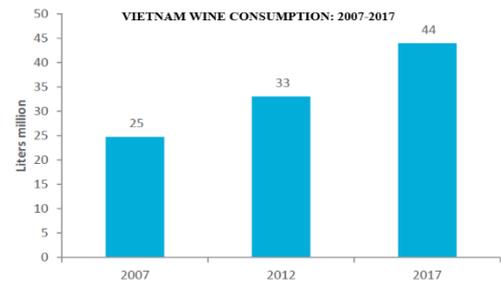


Figure 4: Vietnam wine consumption (2007-2017)

The figure indicates the total Vietnamese wine consumption in 2007-2017. In general, the trend was grown up from 25 liters million (2007) to 33 liters million (2012). By estimation, this volume will increase in the future with product varieties and high quality standard, followed by 44 liters million.

4. CURRENT SIM WINE VALUE CHAIN

No.	Year	Productivity	Total Value (million VND)
1	2013	5000	1.250
2	2014	8000	2.000
3	2015	10000	2.500

4.1 Data analysis

According to the historical data from the Department of Agriculture and Rural development of Kon Plong district, Kon Tum province, there are generally information included the productivity of Sim wine total value. The nearest 3 years production is shown in the table below:

Table 1: Information of Sim wine productivity

Source: Department of Agriculture and Rural development of Kon Plong district

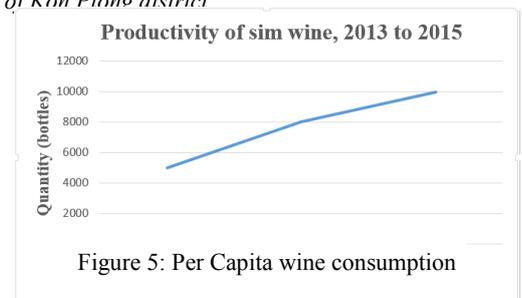


Figure 5: Per Capita wine consumption

Source: Euro Monitor International

Through the graph, the general trend for Myrtle wine productivity was increased in the number of bottles over the period. This number rose gradually from 5000 bottles to 10000 bottles in 2015. Fortunately, the quantity of Sim wine would increase in the future.

4.2 Current Sim wine value chain

The current Mang Den Sim wine value chain is involved some actors consist of collectors, company, retailers and consumers. These factors have linkages between them starting from suppliers to the end consumers and each stage has different function during the structure. Also, it depends on local context of properties of product, market information and production volume.

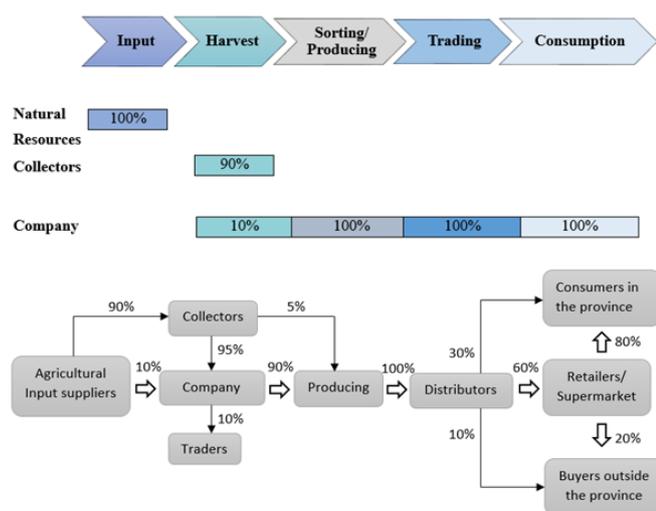


Figure 6: Current Sim wine value chain
 Source: Department of Agriculture and Rural
 Development of Kon Plong district

Firstly, local collectors are important player to supply input for whole manufacturing system. After harvesting of Sim in forests is carried out by suppliers, they sell raw materials directly to company and traders. In the main season, the selling price at the level of company or collectors is within the range of VND 10,000-13,000 per kg [USD 0.5-0.7]. However, based

on weather condition or collecting randomly by local people, producers cannot ensure the quantity as well as the quality of fruits. In some cases, the collected fruit is over but the production activities is limited as undefined planning process about facilities, storage conditions and the volume demand.

Secondly, after collecting the raw materials from local collectors, the sim fruit is produced wine mainly in winery by company, which is the largest company provide sim wine in Mang Den, and made into alcohol or syrup individually at household level. In addition, company responsible for processing and trading inside and outside. With different methods making from sim fruit, it leads to have various products related to red wine and myrtle liqueur.

Nextly, following the distribution channel, the finished goods is distributed by transfer to agency which located in Kon Plong district and co-operate with other partner such as Coop-Mart, Vinmart, Lotusmart in Ho Chi Minh City. Then, the product exchange continuously to retailers or supermarket. In this stage, there are two kind of customer contain consumers travel around the area and buy directly products in retail store outlet in Kon Plong, and buyer in some retails outside the district. However, in some cases, the consumption is to through agency delivery the products to customers who bypass the network and use online system. Although customers have many convenient for this transfer, it affect the transportation cost and time delivery.

4.3 Making Improvement for Sim wine value chain

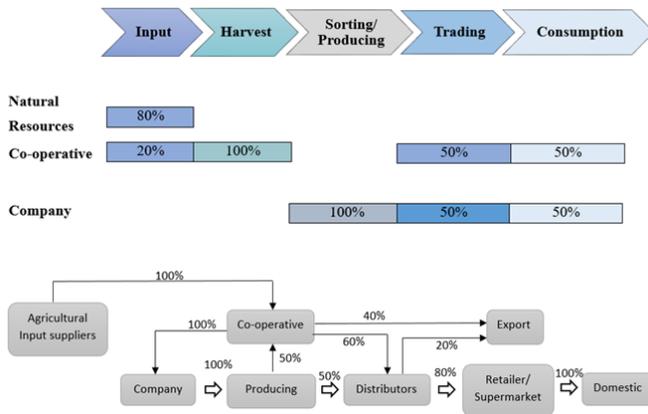


Figure 7: Current Sim wine value chain

Source: Department of Agriculture and Rural Development of Kon Plong district

Despite its potential, there is lack of knowledge and concentration on different aspects of the Sim fruit as well as Sim wine in Mang Den. Therefore, based on the research, the chain should be change in order to operate the system efficiently and effectively. It is also opportunities for market access improvement with to enhance the sector's performance. In this case, the involvement of co-operative in the chain help to improve the current situation. In particular, co-operative will control mainly the input and output in the system related to:

- **Input:** because of poor planting, management and harvesting techniques, Sim fruit is not used effectively and controlled its quality. Therefore, the co-operative have a plan to manage the raw materials by protecting the exist Sim wine plants in natural forests combine with planting and increasing in other areas. The co-operative become the main supplier for Sim wine production in Kon Plong.

- **Trading:** the co-operative contribute to the market chain that help expand the consumption of the products. Moreover, because of the increase of global wine, export is significant step to develop production and brand name in foreign market. In order to understand the commercial activities, they need to get better of the economy at local level

in term of value, sustainability which support for transportation, post-harvested management, market information, organized marketing support and price stabilization.

5. SIM WINE PRODUCT DESIGN & FACILITIES

PLANNING

5.1 Sim wine product design

According to Texas Wine Marketing Research Institute, the wine style of respondents are preferred 50.6 percent red wine, compared to white 30.1 percent and blush wine 17.5 percent. In particular, dry style of wine is 45.2 percent, compared to sweet wine of 43.8 percent by the respondents. There are six products are proposed conducted by in-depth interview of producers and market research of mentioned information source to satisfied various customers 'requirement:

- Myrtle liquor 24% vol
- Myrtle wine 12% vol
- Myrtle wine 14% vol
- Sweet wine 14% vol
- Myrtle syrup
- Honey myrtle

Based on the development the proposed products, it help to improve the current situation. Firstly, adapting customer demand in new market is accomplished. Also, the variety of products lead to increase the awareness' customers and utilize the potential products in this area. Then, the improvement in production system conduct to use Sim fruit effectively and bring many benefit for local area as well as local people.

5.2 Facilities Planning

The designed supply chain network indicates the planned capacity for each proposed product and the planned for facilities of each unit as manufacturing activities in factory.

Winery is built which close to planting areas and have convenient for transportation. It have a multi-function for whole production activities from raw materials to finished goods such as collecting, processing and storing.

By briefly analysis, the features of producing wine is quite small product volume for variety of product. Therefore, the study is followed the process layout for constructing the plant because of its advantages related to machine utilization, space area minimization and cost reduction for investment.

The internal of the plant contains ten departments corresponding with the areas: inspection area, washing area, crushing and pressing area, primary fermentation area, clarification area, second fermentation area, filter pressing area, aging area, hydrolyzing area and bottling area. Each department have different function with responsible for its work which affect to the whole system.

A quadratic assignment problem is apply to determine layout of the plant including variables, objective function, constraints. The purpose is to minimize the flow distance among the group machines (Francis et.al., 1992).

The sets and indices by following:

$D(l,j)$: the distance between the locations l to j in rectilinear distance

$F(m,i)$: the material flow between group m and i

L, J : the number of potential candidate locations

M, I : the number of machine groups

Decision variables:

$$y(m,l) = \begin{cases} 1 & \text{if the } m\text{th machine group is assigned to location } l \\ 0 & \text{otherwise} \end{cases}$$

$$x(m,l,i,j) = \begin{cases} 1 & \text{if the } m\text{th machine group is assigned to location } l \text{ and the } i\text{th machine group is assigned to location } j \\ 0 & \text{otherwise} \end{cases}$$

The facility layout problem can now be for formulated as this:

$$\text{Min} \sum_{m=1}^M \sum_{l=1}^L \sum_{i=1}^I \sum_{j=1}^J D(l,j) * F(m,i) * x(m,l,i,j)$$

The objective function has the meaning minimize total sum of the flow distance if m th machine group is assigned to location l and the i th machine group is assigned to location j . Then, the total flow distance of the layout will be minimized

by objective function subject to following constraints:

$$\sum_{m=1}^M y(m,l) = 1 \quad \text{for every } l \in L \quad (1)$$

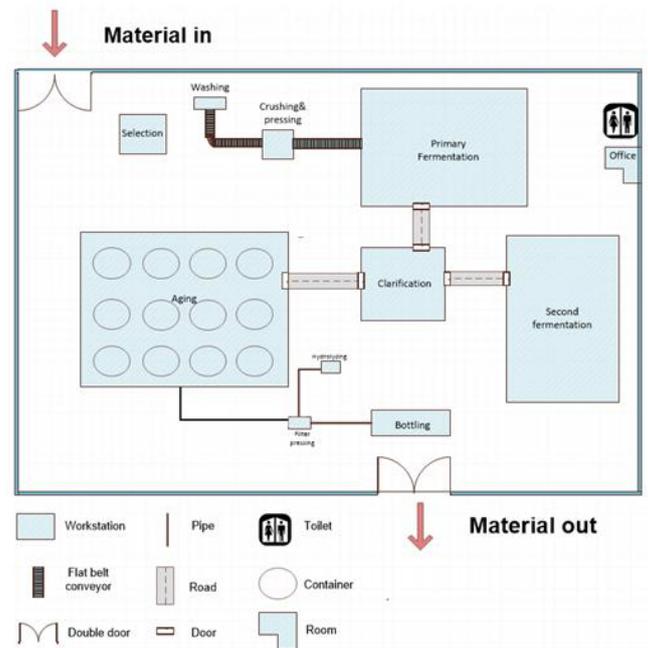
$$\sum_{l=1}^L y(m,l) \leq 1 \quad \text{for every } m \in M \quad (2)$$

$$x \geq y(m,l) + y(i,j) - 1 \quad \text{for every } m,l,i,j \in M,L,I,J \quad (3)$$

$$y(m,l) \in \{0,1\} \quad \text{for every } m,l \quad (4)$$

The constraint (1) stipulates that every slot is assigned one machine group. The constraint (2) states that every machine is assigned in one slot. The constraint (3) indicates that if machine m is assigned in location l , machine i is not assigned in location j and conversely. The constraint (4) illustrate the machine m is assigned in location l or not.

After constructing the model, the optimal solution for new layout is found which minimize flow distance between machine groups by starting with an initial random sequence. Then, the proposed floor plan for the workshop in the figure:



6. CONCLUDING REMARKS

The global market for wine product is changed due to highly concentrated production and increasingly entire consumption. This trend will be uncertain over period depend

on the demand and supply of wine in each countries. In VietNam, Myrtle wine in Mang Den, Kon Plong district is a potential product which has high quality and value but it is not exploited effectively in current. By research in different aspects, the six type of Sim fruit products is proposed to satisfy the customer habits combine with develop Sim fruit exploitation. Moreover, identifying the potential market for Sim wine product is concerned because of the increased wine trend domestic and foreign market.

The problem seem to be solved by proposing the new winery in this area. This plant is recommended to locate in Hieu ward which can utilize the smallest total distance to supplier and customer. The suggested plant has total 950 m² that producing more than 200,000kg Sim fruit with six type of products per year.

It is suggested to do more study on the topic: applying the sustainable supply chain network design model will help to develop certainly the wine production sectors and get more benefits in the future. Furthermore, a better market research as foreign market is to get a chance exporting and compete with other countries.

It is highly recommended for the local authority to consider for implementing the plan. If this plan is worked and done successfully, it can be apply for many of the other products in the area which is now have the similar problem with Sim fruit.

From the result of this study, we contribute further study to the supply chain design of the Vietnam agriculture products, especially in highland area. Our finding also further understanding of the customer's requirement of Sim wine and the solution as well, which is critical for the current supply chain. Based on this study, further research to develop the supply chains for Sim wine and other typical fruits in highland of Vietnam could be conducted.

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