Article

Clustering Production and Operational Practices of SME Using Correspondence Analysis: A Case Study of Northern OTOP Thailand

Sarayut Malaipun [1], Pongsakorn Surin [1], Wiwat Singsai [1] and Wichai Chattinnawat [2,*]

[1] Department of Industrial Engineering, Faculty of Engineering, Rajamangala University of Technology Lanna Chiang Mai, 128 Huay Kaew Rd, Tambon Chang Phueak, Mueang Chiang Mai District, Chiang Mai 50300, Thailand; s.malaipun@rmutl.ac.th (S.M), pongsakorn.surin@rmutl.ac.th (P.S), wiwat.singsai@rmutl.ac.th (W.S).

[2] Department of Industrial Engineering, Faculty of Engineering, Chiang Mai University, 239 Huay Kaew Rd, Tambon Su Thep, Mueang Chiang Mai District, Chiang Mai 50200, Thailand.

* Correspondence: chattinw@eng.cmu.ac.th (W.C).

Abstract: This study aims to identify the actual conditions of the current operational practices of the One Tambon One Product (OTOP) and the actual sales and income. This research summarizes and classifies the existing practices concerning different groups of OTOP products and presents empirical evidence on how and what practices correspond to the actual business performance. This research adopted correspondence analysis as a data analysis and visualization tool to summarize and present if clusters or relationships exist among categorical variables of OTOP groups, operation practices and their revenue performances. The results can then be used to define the right set of operations on the OTOP group for the Thai government to develop a supporting policy.

Keywords: One Tambon One Product (OTOP); operation practice; clustering production; small and medium enterprises (SMEs); correspondence analysis.

1. Introduction

The Thai government has conducted the Thailand One Tambon One Product (OTOP) program since 2001. This OPTOP has been considered one of the key strategies for the local development of the Thai government. This program aimed to strengthen the "grass roots" local economy to generate income for the locals and the country (Suttipong et al., 2022). This OTOP program has successfully enhanced and contributed to the local Thai economy and is considered the endogenous regional development concept (Mukhjang, 2017). The OTOP program concept strategically utilizes the available local resources, i.e., agriculture products, to create aesthetic and highly valued products reflecting the local culture (Sensang et

al., 2022). The OTOP products are made, and the business is run by the individual local entrepreneur or community-based cooperative with the support of the Thai Government. The Ministry of Industry, Community Development Department, Ministry of Interior, Department of International Trade Promotion, and Ministry of Commerce have supported the OTOP project and conducted several initiatives to expand and sustain the OTOP business. The marketing channels have been created to increase the sale opportunity and revenue for the OTOP. The business channels and centres, i.e., the Thaitrade.com is one of Thailand's official B2B E-Marketplace sale channels developed to provide OTOP with more export opportunities. Even though the marketing channel expansion allows OTOP entrepreneurs and SMEs to gain higher income from domestic and international purchase orders, new product development, business and operation management are all needed by the local entrepreneur as a main part of the value chain. The government is also interested in assessing the business and operation performance of the OTOP to develop an integrated policy and platform for the supporting plan.

The Community Development Department, Ministry of Interior, several programs have been initiated to increase not only the value of the product but also the operational performance and capabilities of the OTOP. In addition to branding and new product development that can increase the sale and revenue sale of the business, the organization transformation and operation management also plays an important part in the supporting components for the business performance. The good practices of operation and operation management help businesses increase responsiveness to customer demands. Nanthasudsawaeng (2019) reported the top important factors affecting entrepreneurs' performance improvement, including Key Activities, Value Proposition, Key Resources, and Cost Structure. Sitabutr & Deebhijarn (2017) revealed that the OTOP product brand could be influenced by not only the perceived quality but also the competitiveness, trust, and distribution satisfaction. Hence production and operation practices that lead to higher business expansion and revenue growth are needed to be incorporated into the government policy to support the local OTOP entrepreneur.

Even though it is a common understanding that production and operation management is needed for all organizations, the management system and investment cost are barriers to local and SME development. Especially for the local OTOP entrepreneur, the management skills and resources are limited. In order to decide which best practices should be adopted and invested in for the OTOP, the government needs to justify if those practices are associated with the actual performance of the OTOP. The government lacks actual data on the sales and incomes of the OTOP, which consist of five main products. Neither is the existing research report conducting the actual field and site visit to the OTOP and evaluating current production and operation practices. Much research related to OTOP performances is derived mostly from the data collected from the questionnaire and secondary sources. Evaluating production and operation practices can be very difficult and not precise. The actual field visit with records & site audit yields more accuracy for the subjective evaluation. Hence this research aims first to identify the actual conditions of the current operational practices of the OTOP and the actual sales and income, which can be different for different OTOP product groups. Second, this research aims to summarize and classify the existing practices concerning different groups of OTOP products. Lastly, this research aims to present empirical evidence on how and what practices at which level that is corresponding to the actual business performance. The results can then be used to define the right set of operations for the OTOP group for the Thai government to develop a supporting policy.

This study aims to validate and classify the relationship between the production and operation practices consisting of Stock Management, Technology and Innovation, and the driving factor at the supply chain operational level, which are the Cost and Data management among different OTOP groups. This and the actual business performance in terms of revenue growth. This research developed, summarized and presented the existing conditions of the current operational practices of the OTOP, the actual sales and income, which can be different for different OTOP product groups using the pairwise correspondence analysis. The correspondence analysis can be used to analyze the pattern of relationships among several categorical dependent variables (Greenacre & Blasius, 2006). This research adopted the correspondence analysis as both a data analysis and data visualization tool to summarize and present if there exists a relationship between practices variables and OTOP cluster and their revenue performance. Section 2 provides a literature review of the OTOP business and its operation. The methodology for summarising those practices and steps of analysis is explained in section 3. The results and discussion are provided in section 4, followed by the conclusion in the last section.

2. Literature Review

The information on the business performance and revenue of the OTOP helps the government to evaluate the achievement of the OTOP project. The information on the current capability of the existing OTOP management is also important for the government to deploy policies for supporting the business. Past research has been conducted to understand and define what drivers or variables relate to the sale and export performances of OTOP in different markets and contexts (Leonidou, 2004; Sousa, 2004). The results showed that sales and export performance are closely related to size, age, and entrepreneurship (Ogunmokun & Ng, 2004). The key factors that can contribute to a firm's export performance are organizational characteristics, capabilities, management, and strategy (Voerman, 2003). Operation and production management affect the business value chain and can significantly impact business performance and increase the OTOP. Nanthasudsawaeng (2019) reported that not only the Value Proposition but also the Key Resources, Key Activities, and Cost Structure are all important top drivers for OTOP performance.

Competitiveness and distribution satisfaction is also important in entrepreneurial performance (Sitabutr & Deebhijarn, 2018). Several researchers have pointed out the status, impact, and factors relating to the success of the OTOP business without considering the operational context of the OTOP. For example, (Tuamsuk et al., 2013) investigated and identified the knowledge management factors that affect the success of five-star OTOP businesses in Thailand. In contrast, Thammasang & Poonikom (2016) aimed to select the important set of indicators associated with the knowledge management of OTOP. Most authors reported only the success factors in the knowledge management of the business. However, lacking business, experience and financial support can lead to business failure (Vanpetch & Sattayathamrongthian, 2019). Hence other than the cost, distribution and stock management that relate to customer satisfaction and sales, the needs of innovation, IT management that support sale and business alignment play crucial roles for the business as well as the OTOP. Thus, current research may not sufficiently provide information on operational drivers that affect the OTOP business performance. Hence this research presents statistical analysis model based on extensive field surveys and interviews of OTOP in northern Thailand.

This research used pairwise correspondence analysis to summarize and cluster the common operational practices among different OTOP groups concerning their actual business performance revenue growth. The observed practices defined as variables and the OTOP category were classified with the categorical scale. The correspondence analysis technique was used to identify the existing relationship of those categorical variables and to detect and present underlying structures of the relationship. This research proposed the relationships using pairwise correspondence analysis. The correspondence analysis (CA) can be used to analyze the pattern of relationships between categorical dependent variables (Greenacre & Blasius, 2006). The CA is one classification tool based on the indicator matrix, a complete disjunctive table generated from the categorical variables (Greenacre, 2013). The CA analyzes the information of the indicator matrix or the symmetric matrix of all two-way cross-tabulations between those categorical variables and develops the covariance matrix analogous to the covariance matrix of the continuous variables. The results of conditional distribution and similar Eigenvectors can be used to display those categorical variables with graphical plot with points coordinated through selected pair of variables.

The CA analysis has been adopted and used in several fields, especially consumer behaviour and marketing. Hwang et al. (2006) proposed extending the multiple correspondence analysis that considers clusters or levels of heterogeneity in respondents' preferences/choices. Ladron-de-Guevara et al. (2006) adopted the CA to investigate potential relationships between a firm's ethical practices with the customers and supplier's perception within a supply chain. It can help identify particular sectoral and cultural influences that might be used to draw conclusions and practices needed for the firm. In this research we would like to adopt a similar CA technique to identify the relationship between different OTOP groups and their current practices and if there exist the clusters or association between operation management and the actual revenue increase of the OTOP. Up to present knowledge, there no OTOP related research in the past that have adopted the CA to identify the actual OTOP performances that could be different among the different groups of OTOP with some key cultural characteristics, the operation characteristics. This research adopted the CA as an analysis and data visualization tool to summarize and present the significant relationship to guide the government's policy implementation.

3. Methodology
3.1. Variables and Scales of Measurement

This research first aims to identify and summarize the current focuses on the operational practices and the OTOP business performances in revenue growth using the correspondence analysis. This research

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defined and measured the revenue growth and operation practices factors as in Table 1 with the categorical scales.

Table 1. Attributes and Categorical Scales of the OTOP Business Performances and Practices.

Variable	Level	Category
Revenue Growth	1	Varied within -5% to 5%
	2	Increased 5% to 10%
	3	Increased 10% to 20%
	4	Increased more than 20%
Stock Managemnet	1	Low Efficient stock MGMT
	2	Medium Efficient stock MGMT
	3	High Efficient stock MGMT
Technology and Innovation Adoption	1	No Techno&Inno Adoption
	2	Some Technology Adoption
	3	With Technology & Innovation Adoption
Data, IT connected with business	1	Costing Data Exist
	2	Level1+Data & IT connected with Business
	3	Level2+Business Improvement

3.2. Data Collection

This study aims to improve the business opportunity for the OTOP in the northern region. The data were collected using site visits and face-to-face interviews with OTOP producers from three provinces in northern Thailand. This research used the sampling table to proportionally select a sample for the population size of OTOP producers from those 5 main groups of (i) Food, (ii) clothes, apparel, and accessories, (iii) Beverages, (iv) Herbal products, and (v) Utensils, Decorative items and Souvenirs. These five groups of OTOP producers were defined as the population for this study. The sample collected from field visits at each producer in the three provinces of Chiang Mai, Lumphun, and Lampang. A total of 101 selected producers were visited, interviewed and assessed for their current sales, revenue and business condition. Each selected OTOP producer was assessed with their current condition and practices on the operational and supply chain management. The distribution of the sampled OTOP producer was depicted in Figure 1.
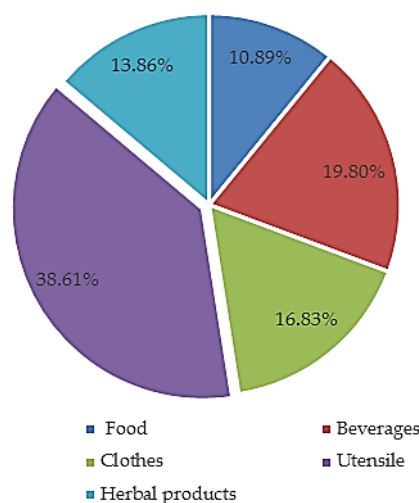

Figure 1. Distribution of the selected samples.

The interviewers used the site audit and evidence to conclude the revenue rating results and those operational management practices. Each respondent was interviewed and assessed with the business

performance in terms of the revenue based on the available data during the last year, 2019 based on the records. The respondents were interviewed and asked to explain the practices employed in the past, especially in 2019. The data were cross-checked with the information audited on the site with current practices to ensure the accuracy and validity of the research. The interviewer audited the production site and evaluated if, for example, the stock management had been developed and what level of practice had been achieved. Also, for the cost and IT system implemented, the interviewer asked and audited the existing system used for controlling the production cost and the electronic system used for the system. The production's cost control can vary depending on the entrepreneurial skill of the OTOP producer.

Thus, the performance rating was justified based on the evidence of practices. For the adoption of technology and innovation, the interviewer used past product development records and asked the respondent to explain how manufacturing has been developed and progressed in the past. The interviewer determines the level at which technology was used. Also, the innovation practice from the product and process was assessed if any adaptation of technology and innovation exists in the development of the new product value or the process of manufacturing, including the business operation. The assessment of each logistic activity was collected and evaluated if the supply chain alignment has been practised and at what level of achievement. The results of 101 collected assessments were then used to analyze and report the current status of both revenue and practices and their relationship.

3.3. Analysis Models of the Relationship

In general, to deduce that operation practices are driving factors that can directly or indirectly contribute to business growth. However, it is difficult to define what driver or enabler for the OTOP, especially from the operational management, to adopt for different groups or categories of various sizes. Each different OTOP group may require or emphasize different operational competencies. Therefore this again indicates that the four basic strategies may not be theoretically applied to the OTOP context (Sousa, 2004). Hence this research will develop new knowledge of what operational practice shall be adopted to enhance the sale and revenue among different groups of OTOP. Therefore, this research is interested in (i) the existing relationship between the practices of the OTOP group (ii) the existing relationship between the business growth concerning the OTOP group, and (iii) the existing relationship between the business growth for the OTOP practice. Thus, this research defines the analysis steps sequentially, as illustrated in Figure 1. This research first identifies the actual conditions of the current operational practices of the OTOP and the actual sales and income, which can be different for different OTOP product groups. The presentation in the forms of clusters and groups was then used to define the existing finding and relationships of the OTOP group. Next, this research summarizes and classify the existing practices concerning different groups of OTOP product. Then, the CA was used to present the empirical evidence on how and what practices at which level that is corresponding to the actual business performance.
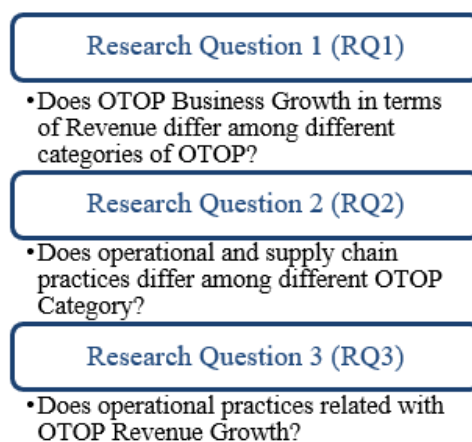

Figure 2. Research Hypothesis Structure for OTOP Performance Modelling.

The CA was used as a data visualization tool to present the cluster and relationship of the operating practices with respect to the OTOP groups and their revenue growth. Each research hypothesis was analyzed using the pairwise correspondence analysis. The OTOP group/category variable and their business revenue growth (Y) were cross-tabulation with each practice (X1-X3) having categorical values. The graphical plots

developed to explore the relationship between the revenue and each practice by accounting for the different groups of the OTOP. Figure 3 depicts the data analysis and model-building process of the research.
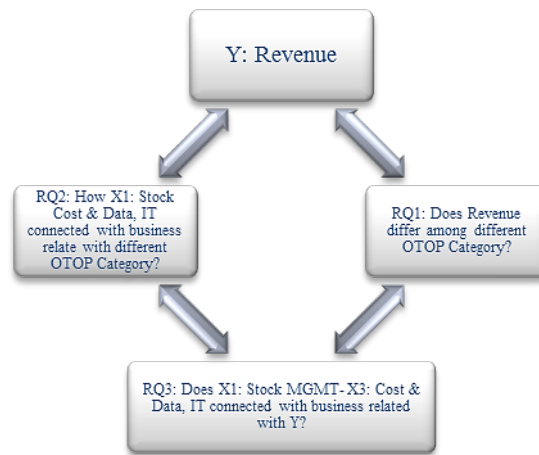

Figure 3. Research Methodology

4. Results

4.1. Distribution of Revenue vs OTOP Category

The analysis of revenue distribution can be depicted in Figure 4.There are no significant differences. There seems to be an equal chance or opportunity for an OTOP to increase their sales and revenue. However, this sale opportunity and revenue may depend on the product's category and value. Hence the classification of the revenue growth with respect to the OTOP category was then developed.
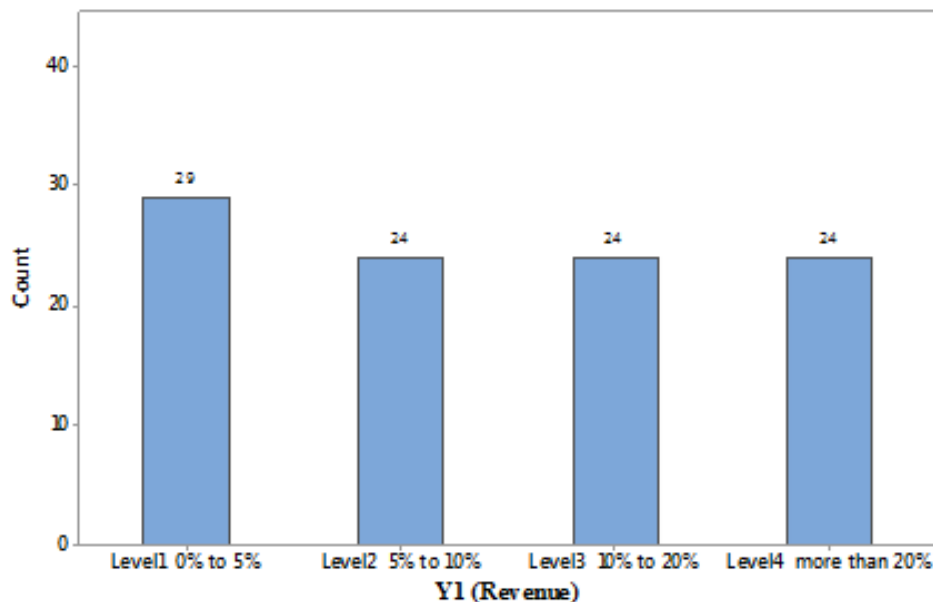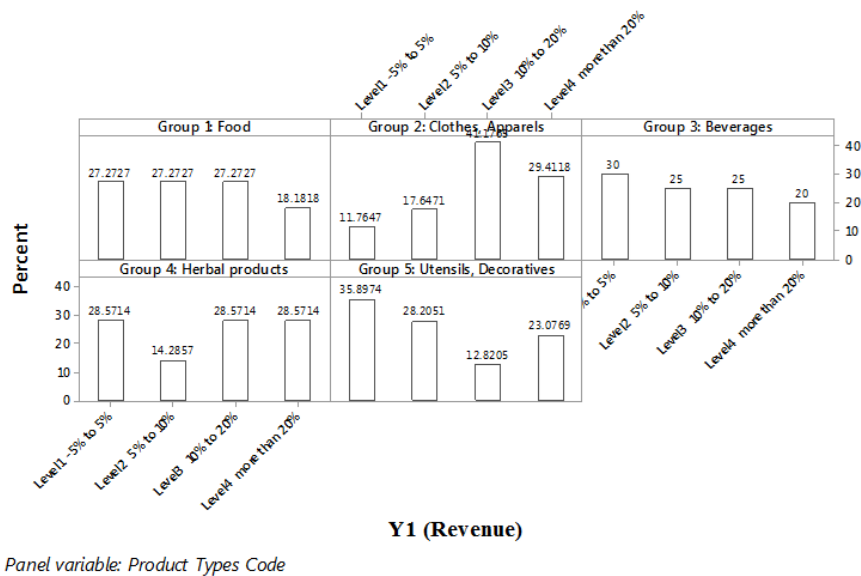
Figure 4. Distribution of Revenue vs OTOP Category

The correspondent analysis results in Table 2 and Figure 5 showed that revenue growth seems to differ among different groups. There are three major clusters of the OTOP category, where cluster 1 consists of Beverages and Food with equal revenue growth opportunities. It is sensible since Food and Beverage groups are closely related. Thus, the business performance is similar. However, Cluster 2, 3, and 4 of Clothes, Herbs and Utensils seem different. The majority of the Clothes and apparel group has revenue growth up to 20%, and many increased by more than 20%. So, in general, this group gain more revenue during 2019, but about 11.7% have stable revenue and income. Herb's cluster shows that more than 56% has more revenue growth than 10% whereas the Utensil and decorative OTOP cluster tends to have a small growth of at most 10%.

Table 2. Simple Correspondence Analysis: Product Types Code, Y1 (Revenue) Analysis of Contingency

Axis	Inertia	Proportion	Cumulative
1	0.0750	0.8820	0.8820
2	0.0074	0.0872	0.9692
3	0.0026	0.0308	1.0000
Total		0.0850	

Table 3. Simple Correspondence Analysis: Product Types Code, Y1 (Revenue) Analysis of Contingency (Row Contributions) – Cont'd

ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	Group1: Foods	0.927	0.109	0.031	-0.025	0.026	0.001	-0.148	0.901	0.320
2	Group 2: Clothes, Apparels	0.985	0.168	0.508	-0.503	0.984	0.567	-0.014	0.001	0.004
3	Group 3: Beverages	0.611	0.198	0.018	0.016	0.033	0.001	-0.067	0.578	0.121
4	Group 4: Herbal products	0.920	0.139	0.093	-0.156	0.425	0.045	0.168	0.495	0.530
5	Group 5: Utensils, Decorative	0.982	0.386	0.349	0.274	0.976	0.386	0.022	0.006	0.024

Table 4. Simple Correspondence Analysis: Product Types Code, Y1 (Revenue) Analysis of Contingency (Column Contributions) – Cont'd

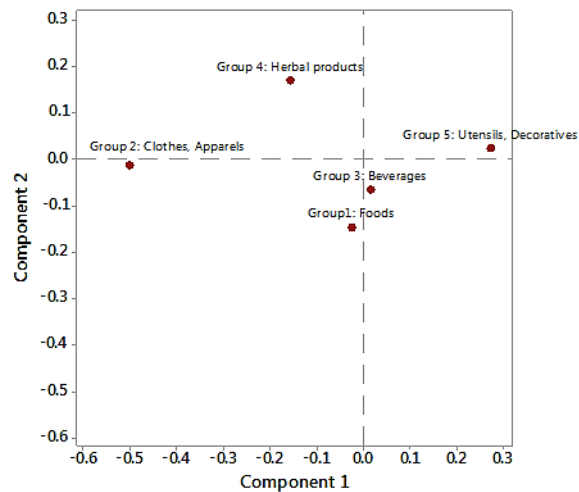| ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	Revenue +/-5%	0.962	0.287	0.282	0.280	0.942	0.301	0.041	0.020	0.066
2	Revenue up 5% to 10%	0.954	0.238	0.139	0.182	0.670	0.105	-0.119	0.284	0.451
3	Revenue up 10% to 20%	0.992	0.238	0.505	-0.421	0.980	0.562	-0.045	0.011	0.066
4	Revenue up more than 20%	0.869	0.238	0.074	-0.100	0.378	0.032	0.114	0.491	0.417

Figure 5. The Correspondence Analysis on Distribution of Revenue vs OTOP Category

Even though the cross-tabulation and Chi-square test does not indicate a statistically significant correlation between the Revenue (Y) and OTOP category, the correspondence analysis provides more information. It can be used as a guideline for investigating different performances of the OTOP group.

4.2. Does Driving Factors differ among different OTOP Category

The analysis of revenue distribution can be depicted in Figure 4, in which there are no significant differences. There seems to be an equal chance or opportunity for an OTOP to increase their sales and revenue. However, this sale opportunity and revenue may depend on the product's category and value. Hence the classification of the revenue growth concerning the OTOP category was then developed. The analysis of the distribution of X1: Stock Management – X4: Supply Chain strategy concerning different OTOP groups can be tabulated and depicted in Figures 6-9, respectively. The results of CA show that the group Food and Beverages, which requires high-quality standards, have utilised the stock management procedure either at a full or partial level. The group of Utensils, Clothes and Herbs are still lacking the good practice in stock management. It is sensible since this group may not need high stock control and management from a practical point of view. Also, from the interview, the full-time staff would incur a high cost for the operation.
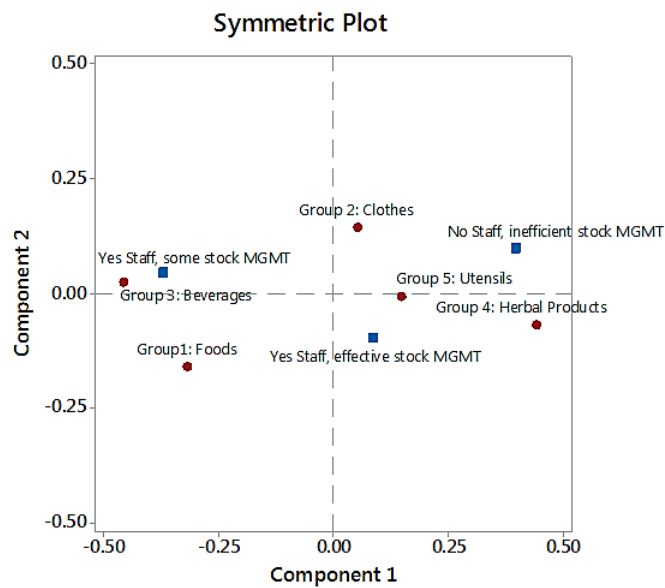
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Figure 6. The CA on X1: Stock Management vs OTOP Category

A similar result was obtained from CA plot that the group Food and Beverages, which requires high quality standards will have to employ technology and innovation for their production. Figure 7 also reveals that the herb al product OTOP group also utilises technology and innovation. It is because the processing and the quality control of the processing of the herbs require technological and science knowledge and procedure. The group of Utensils, Clothes, does not reveal any technology and innovation adoption since the product can be made at conventional procedure or traditional practice. Thus, this group will not need technology and innovation, which will again lead to higher product cost. Regarding the practices of Data and IT connected with the business, the CA plot classify the results into three groups. The Beverage OTOP product group is the only group demonstrating data and IT usage for business. The Herbal product group selected for study all demonstrated the continuous usage of cost, data and IT.
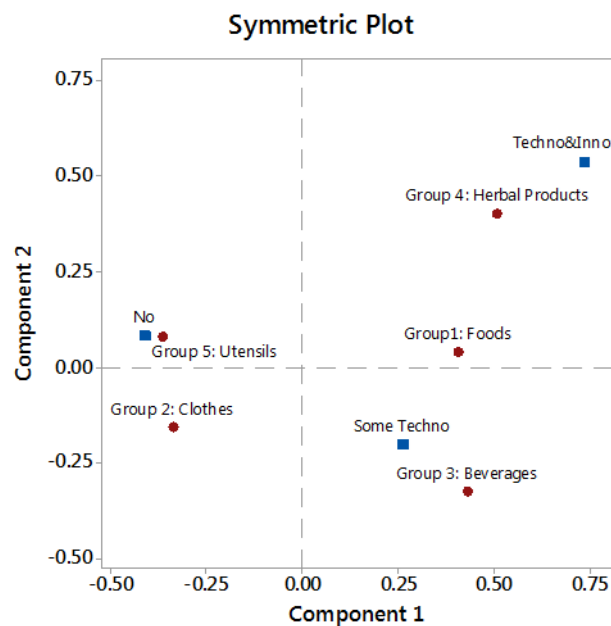

Figure 7. The CA on X2: Technology & Innovation Adoption vs OTOP Category

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It can be observed from the site visit that actual costing is important for the marketing and competitiveness of the herbal product. Hence, this group has shown evidence on the high-level adoption of the data which is also required by the high-quality standard.
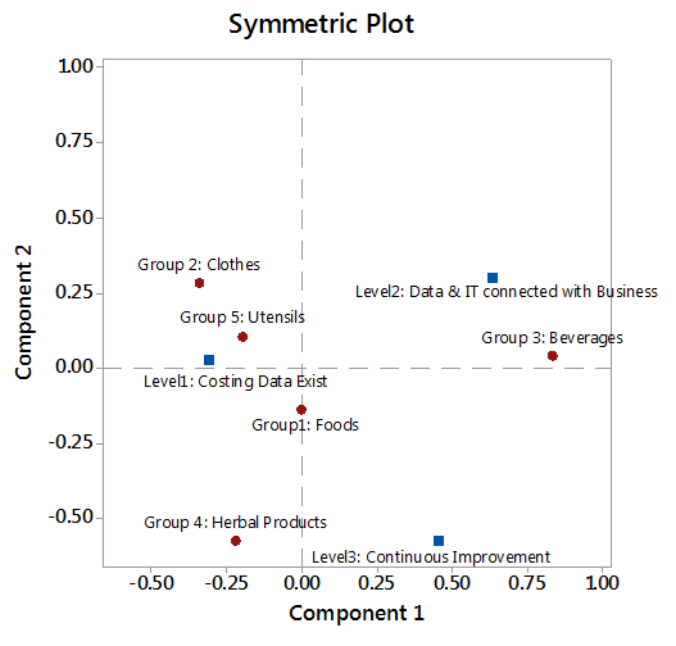

Figure 8. The CA on X3: Data, IT connected with Business vs OTOP Category

In general, we found that the group of Clothes and Utensils are the OTOP groups who tend to not focus and deploy the production and supply chain management concept in their organization. The stock management, DATA and IT or process innovation do not play crucial role. Thus, this groups were found to lack behind the Food, Beverages product group whose production require technology, high quality data control and supply chain and logistic activity. Without good adoption of technology, and stock management, the process can result in high contamination and shorten of product shelf life. Thus, this research reveals that production and operation management practices have been different among different groups of products. This again could lead to different business performance with differed revenue growth which in turn depends on the OTOP category as reported in section 4.4. Next section explains how the production and management factors relate with the revenue growth.

4.3. Does Operation Practices correlate with the Revenue Growth

4.3.1. Analysis on X1: Stock Management

The analysis on the distribution of X1: Stock Management can be tabulated and depicted in Figure 9. The results are sensible and affirm that among OTOP whose stock management is well managed, these OTOP tends to generate higher revenue. We see that for the OTOP producer who do not utilize the staff and periodically has insufficient stock, they fall into the stable revenue. Instead the group with staff and well-managed falls into more revenue growth of up to 20% or more.
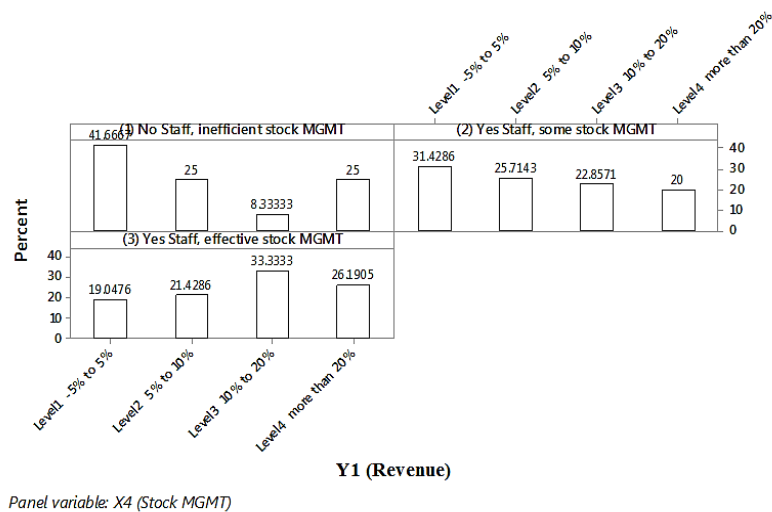
Figure 9. Distribution of Revenue vs Current Practice of X1: Stock Management

The CA also can indicate the same conclusion with the cross-tabulation analysis. The OTOP producer who lack the staff and inconsistent stock sufficiency will tends to have stable income and no revenue growth. However, the group that have staff and deploy stock management will start to have revenue growth. If the full-time staff is employed together with good stock management, the OTOP producer can have revenue growth from at least 10% to more than 20%. Hence the stock management factors does have positive relationship as expected and drive the revenue growth. The details of CA are shown in Figure 10.

Table 3. Simple Correspondence Analysis: X1 (Stock MGMT) vs Y (Revenue) Analysis of Contingency

Axis	Inertia	Proportion	Cumulative
1	0.0692	0.9461	0.9461
2	0.0039	0.0539	1.0000
Total	0.0732		

Table 3. Simple Correspondence Analysis: X1 (Stock MGMT) vs Y (Revenue) Analysis of Contingency (Row Contributions) – Cont'd

ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	No Staff, inefficient stock MGMT	1.000	0.238	0.519	0.395	0.976	0.536	-0.061	0.024	0.226
2	Yes staff, some stock MGMT	1.000	0.347	0.050	0.057	0.307	0.016	0.085	0.693	0.637
3	Yes staff, effective stock MGMT	1.000	0.416	0.431	-0.273	0.983	0.448	-0.036	0.017	0.136

Table 3. Simple Correspondence Analysis: X1 (Stock MGMT) vs Y (Revenue) Analysis of Contingency (Column Contributions) – Cont'd

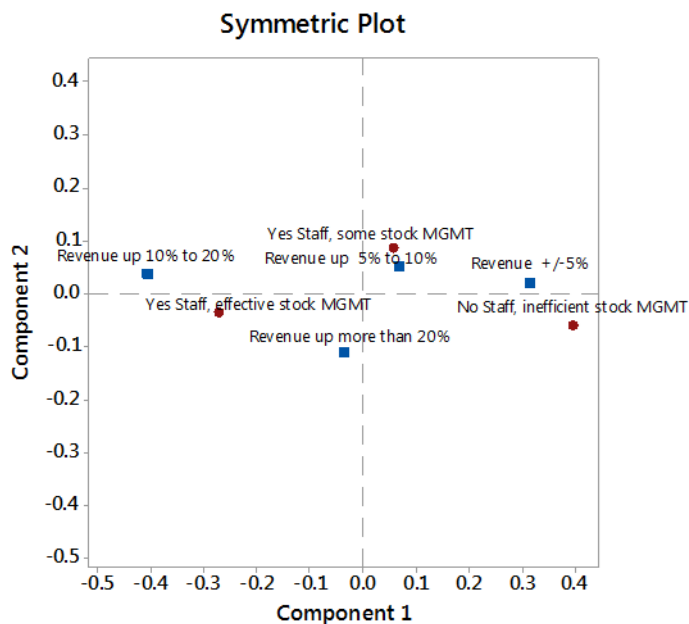| ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	Revenue +/-5%	1.000	0.287	0.387	0.313	0.996	0.407	0.020	0.004	0.029
2	Revenue up 5% to 10%	1.000	0.238	0.023	0.067	0.644	0.015	0.050	0.356	0.150
3	Revenue up 10% to 20%	1.000	0.238	0.546	-0.408	0.992	0.573	0.037	0.008	0.082
4	Revenue up more than 20%	1.000	0.238	0.044	-0.037	0.102	0.005	-0.111	0.898	0.739

Figure 10. The CA on Distribution of Revenue (Y) vs X1: Stock Management

4.3.2. Analysis on X2: Technology and Innovation Adoption

The analysis on the distribution of X2: Technology and Innovation Adoption can be tabulated and depicted in Figure 11. The results are sensible and affirm that among OTOP who implement the Technology and Innovation adoption, these OTOP tends to generate higher revenue. We see that for the OTOP producer who do not utilize the technology and innovation, they have more chance of having no growth of revenue.
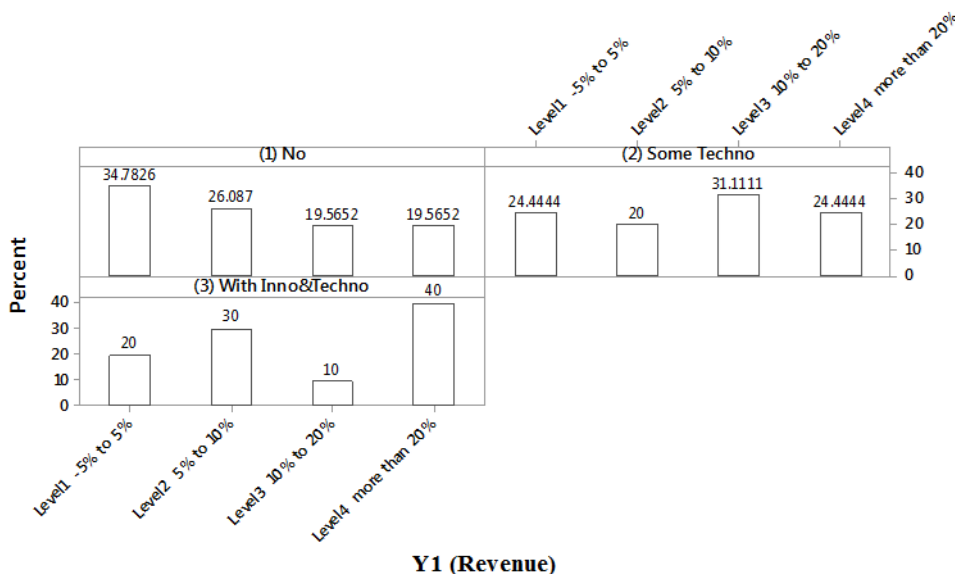
Figure 11. Distribution of Revenue vs Current Practice of X2: Technology and Innovation Adoption

The CA also can indicate the same conclusion with the cross-tabulation analysis. The OTOP producer who adopt the technology and innovation is classified as having the revenue growth more than 20%. For the group that adopt some technology, the revenue growth can be up to only 20%. If the producer dose not adopt the technology or innovation, the revenue growth will be at most 10%. Hence the technology and innovation

adoption does have clear relationship as expected and drive the revenue growth. The details of CA of X2 is shown in Figure 12.
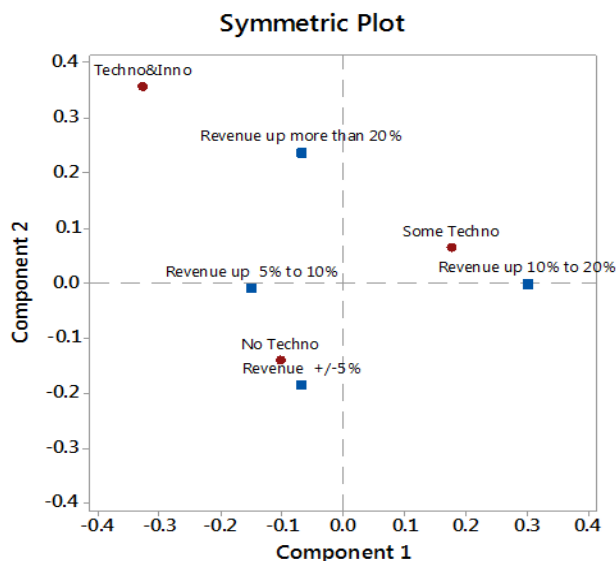

Figure 12. The CA on Distribution of Revenue (Y) vs X2: Technology&Innovation Adoption

Table 4. Simple Correspondence Analysis: X2 Technology & Innovation vs Y (Revenue) Analysis of Contingency

Axis	Inertia	Proportion	Cumulative
1	0.0291	0.5555	0.5555
2	0.0233	0.4445	1.0000
Total	0.0524		

Table 4. Simple Correspondence Analysis: X2 Technology & Innovation vs Y (Revenue) Analysis of Contingency (Row Contributions) – Cont'd

ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	No Techno	1.000	0.455	0.260	-0.102	0.344	0.161	-0.140	0.656	0.383
2	Some Techno	1.000	0.446	0.299	0.176	0.883	0.476	0.064	0.117	0.079
3	Techno&Inno	1.000	0.099	0.441	-0.327	0.457	0.363	0.356	0.543	0.538

Table 4. Simple Correspondence Analysis: X2 Technology & Innovation vs Y (Revenue) Analysis of Contingency (Column Contributions) – Cont'd

ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	Revenue +/-5%	1.000	0.287	0.215	-0.068	0.118	0.046	-0.186	0.882	0.427
2	Revenue up 5% to 10%	1.000	0.238	0.101	-0.149	0.996	0.182	-0.010	0.004	0.001
3	Revenue up 10% to 20%	1.000	0.238	0.408	0.300	1.000	0.734	-0.002	0.000	0.000
4	Revenue up more than 20%	1.000	0.238	0.276	-0.068	0.077	0.038	0.237	0.923	0.572

4.3.3. Analysis on X3: Data, IT connected with business

The analysis on the distribution of X3: Data, IT connected with business can be tabulated and depicted in Figure 13.   The results are sensible and affirm that among OTOP who implement the Data, IT connected with business, these OTOP tends to generate higher revenue. We see that for the OTOP producer who do not utilize the technology and innovation, they have more chance of having no growth of revenue.
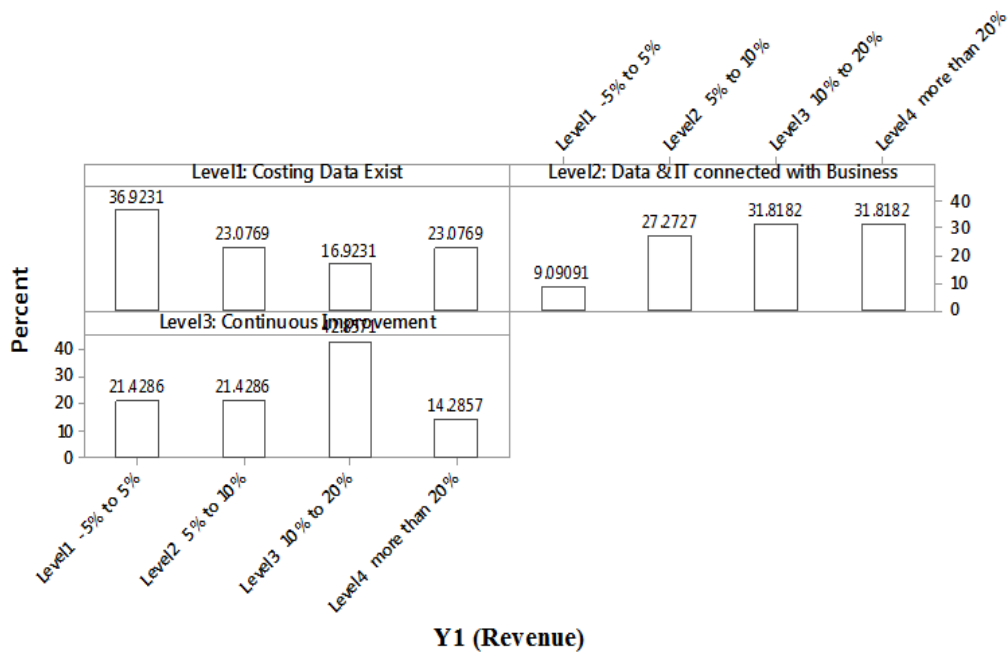
Figure 13. Distribution of Revenue vs Current Practice of X3: Data, IT connected with business

The CA also can indicate the same conclusion with the analysis and similar to the driving factor X2. The OTOP producer who adopt the Data, IT connected with business will be associated with the revenue growth of more than 20%. For the group that does not adopt the Data, IT connected with business, the revenue growth will be at most 10%. Hence the Data, IT connected with business does have clear relationship as expected and drive the revenue growth. The details of CA of X3 is shown in Figure 14.
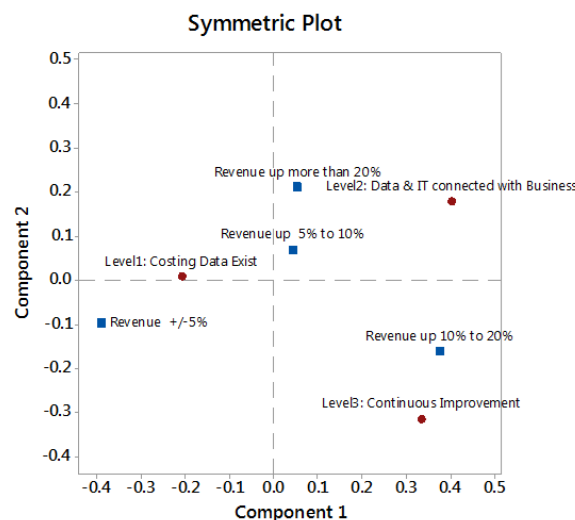

Figure 14. The CA on Distribution of Revenue (Y) vs X3: Data, IT connected with business.

Table 5. Simple Correspondence Analysis: X3 (Cost & DATA, IT connected with Business vs Y(Revenue) Analysis of Contingency

Axis	Inertia	Proportion	Cumulative
1	0.0789	0.7920	0.7920
2	0.0207	0.2080	1.0000
Total	0.0997		

Table 5. Simple Correspondence Analysis: X3 (Cost & DATA, IT connected with Business vs Y (Revenue) Analysis of Contingency (Row Contributions) – Cont'd

ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	Level1: Costing Data Exist	1.000	0.644	0.281	-0.209	0.999	0.355	0.007	0.001	0.002
2	Level2: Data & IT connected with Business	1.000	0.218	0.424	0.403	0.836	0.447	0.179	0.164	0.335
3	Level3: Continuous Improvement	1.000	0.139	0.295	0.336	0.532	0.198	-0.315	0.468	0.663

Table 5. Simple Correspondence Analysis: X3 (Cost & DATA, IT connected with Business vs Y (Revenue) Analysis of Contingency (Column Contributions) – Cont'd

ID	Name	Qual	Mass	Inert	Component 1			Component 2		
					Coord	Corr	Contr	Coord	Corr	Contr
1	Revenue +/-5%	1.000	0.287	0.470	-0.392	0.941	0.559	-0.098	0.059	0.134
2	Revenue up 5% to 10%	1.000	0.238	0.016	0.044	0.287	0.006	0.069	0.713	0.054
3	Revenue up 10% to 20%	1.000	0.238	0.400	0.376	0.844	0.427	-0.162	0.156	0.299
4	Revenue up more than 20%	1.000	0.238	0.114	0.053	0.060	0.009	0.212	0.940	0.513

5. Discussion

The correspondence analysis was applied to shed light on the basic hypothetical research questions. First, this research found that the revenue growth seems to be different among different group. There are three major clusters of OTOP category where cluster 1 consists of the Beverages and Food who's their revenue growth could fall under different scenarios with equal opportunity.   We also find that the Food and Beverage group are closely related and reported the same pattern of business performance. We also found that this group tends to have the same pace of production, operation and supply chain management. We found that Cluster 2, 3, 4 of Clothes, Herbs and Utensils respectively have different revenue growth patterns. Majority of Clothes and apparel group has revenue growth up to 20% and many were increased more than 20%. So, in general this group gain more revenue during the 2019 but about 11.7% have stable revenue and income. The Herbs cluster show that more than 56% has more revenue growth than 10% whereas the Utensil and decorative OTOP cluster tends to have small revenue growth of at most 10%.

The analysis on the stock management, Technology and Innovation Adoption, Data and IT connected with business shows that these are being practiced at different level for different groups of OTOP product. This correspondence analysis help revealing and presenting the relationship between these practices and achievement of business with respect to the OTOP category. The relationship of the practices and the revenue growth can be used for the policy development on which practices can be promoted in order to increase generate more revenue for the local. For example, we found that for the OTOP producer who do not utilize the technology and innovation, they have more chance of having no growth of revenue. Similarly, the correspondence analysis indicates the same conclusion that the OTOP producer who adopt the effective strategy of stock management and Data, IT connected with business will be associated with the revenue growth. For the group that does not adopt the Data, IT connected with business, the revenue growth will be

limited to possibly at most 10%. However, we found other factor that might also drive the revenue growth rather than the operation and supply chain strategy such as value of the OTOP product itself.

6. Conclusions

In conclusion, this study has identified the current operational and supply chain management practices of the OTOP producer and justified the relationship between the operational and supply chain management factors that can contribute to the business performance and revenue growth of the OTOP producer. This research collected data from 101 OTOP producers in northern Thailand's three provinces. The data were obtained and validated using field visit and site audits. This research developed and used correspondence analysis to identify the relationship and classify current practices for different OTOP groups. The correspondence analysis (CA) was used to analyze the pattern of relationships among several pairs of categorical responses and driven operational and supply chain variables. The results can then be used to define the right set of operations for the OTOP group for the Thai government to develop a supporting policy.

References

Greenacre, M., & Blasius, J. (2006). *Multiple correspondence analysis and related methods*. Chapman and Hall/CRC.

Greenacre, M. J. (2013). Correspondence analysis. *The Oxford Handbook of Quantitative Methods. Statistical Analyses*, *2*, 142–153.

Hwang, H., Dillon, W. R., & Takane, Y. (2006). An extension of multiple correspondence analysis for identifying heterogeneous subgroups of respondents. *Psychometrika*, *71*(1), 161–171. https://doi.org/10.1007/s11336-004-1173-x

Ladron-de-Guevara, A., Torres, A., & Tribo, J. A. (2006). Perceptual Mapping of Practical Ethics Along the Value Chain: A Multiple Correspondence Analysis with Industry and Cultural Indices as Supplementary Variables. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1002292

Leonidou, L. C. (2004). An analysis of the barriers hindering small business export development. *Journal of Small Business Management*, *42*(3), 279–302. https://doi.org/10.1111/j.1540-627X.2004.00112.x

Mukhjang, R. (2017). Endogenous Regional Development: The Case of One Tambol One Product in the Lower North of Thailand, Location Quotient Analysis. *Proceedings of International Academic Conferences*, *5407705*.

Nanthasudsawaeng, K. (2019). Guidelines for Increasing Operational Efficiency for Entrepreneurs of One Tambon One Product (OTOP) in Rayong. *International Conference on Interactive Collaborative Learning*, 351–356.

Ogunmokun, G., & Ng, S. (2004). Factors influencing export performance in international marketing: A study of Australian firms. *International Journal of Management*, *21*(2), 172.

Sensang, P., Jomvong, T., Santianotai, R., & Chattinnawat, W. (2022). New Product Development Framework based on University-Community Engagement: Case Study of Thailand OTOP Development for Elderly Consumer. *International Journal of Global Optimization and Its Application*, *1*(1), 1–11. https://doi.org/10.56225/ijgoia.v1i1.8

Sitabutr, V., & Deebhijarn, S. (2017). Community-based enterprise export strategy success: Thailand's OTOP branding program. *Business and Economic Horizons (BEH)*, *13*(1232-2017–2428), 368–382. https://doi.org/10.22004/ag.econ.264706

Sitabutr, V., & Deebhijarn, S. (2018). Community-Based Enterprise (CBE) Export Performance Strategy: An Analysis of Thailand's Entrepreneurial OTOP Program. *Asia-Pacific Social Science Review*, *18*(1), 91–110.

Sousa, C. M. P. (2004). Export performance measurement: an evaluation of the empirical research in the literature. *Academy of Marketing Science Review*, *4*(9), 1–22.

Suttipong, R., Phanphet, S., Wangmai, A., Reungsri, S., & Chattinnawat, W. (2022). Extended AHP Approach with Latent Factor and Stratum in Prioritizing and Positioning of OTOP Thailand's Program for Elderly Market. *International Journal of Global Optimization and Its Application*, *1*(1), 22–31. https://doi.org/10.56225/ijgoia.v1i1.10

Thammasang, S., & Poonikom, K. (2016). The Development of Indicators and Form of Knowledge Management in Production Management Case Study: Agricultural Machine Industry in the Northeast of Thailand. *International Journal of Applied Engineering Research*, *11*(22), 10912–10922.

Tuamsuk, K., Phabu, T., & Vongprasert, C. (2013). Knowledge management model of community business: Thai OTOP Champions. *Journal of Knowledge Management*, *17*(3), 363–378. https://doi.org/10.1108/JKM-10-2012-0321

Vanpetch, Y., & Sattayathamrongthian, M. (2019). Local Entrepreneurial Projects Failure In Thailand: The Case Of Suphanburi OTOP. *Actual Economy: Local Solutions for Global Challenges*, 324–331.

Voerman, J. A. (2003). *The export performance of European SMEs*. Labyrint Publication The Netherlands.