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EVALUATING THE IMPACTS OF SUPPLY CHAIN MANAGEMENT PRACTICES ON PERFORMANCE OF THE TEA SUB SECTOR IN DEVELOPING COUNTRY

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Abstract: Effective supply chain management is essential for boosting competitive production in industries like the tea subsector. However, overlooking certain practices has been shown to have negative consequences for the performance of the subsector. Therefore, it is vital for stakeholders to understand the implications of these practices. This study utilizes a FullEX approach to examine how supply chain management practices (SCMP) impact the performance of Kenya's tea subsector. By conducting a thorough review of existing literature, a two-level criteria framework for these practices is established including 5 criteria in level-1 and 15 criteria in level-2. Comparative analysis is then conducted to gauge the strength of our approach. The results indicate that while customer relationship management is the primary driver of performance in Kenya's tea subsector, additional factors include coordinating resource-sharing initiatives, managing product processes, ensuring customer satisfaction with product value, optimizing distribution channel networks, and enhancing internal integration. The study delivers comprehensive implications and insights relevant to managers and suppliers in tea manufacturing, scholars, researchers, policymakers in Kenya's tea subsector, the wider community, and tea farmers engaged in the industry.

Keywords: Supply chain management, Tea sub-sector, FullEX, Practice, Kenya.

MSC: 90B50.

1. INTRODUCTION

Supply chain management (SCM) is paramount for any company. Any disruption in the supply chain (SC) network can significantly impact the entire system, underscoring the importance of effective SC integration [1, 2]. A company's growth relies on aligning its goals with its SC strategy, as both converge in management [3]. The impact of SC practices on performance is a key research focus [4]. Researchers highlighted different facets of supply chain management practices (SCMPs) based on their specific objectives [2, 5]. In industries like the tea subsector in Kenya, effective SCM is crucial for increasing competitive production. This entails integrating internal company functions and closely connecting them with outside operations involving customers, suppliers, and other network members [6].

Tea is a valuable commodity with diverse advantages for both individuals and economies worldwide. It is the second most consumed beverage globally after water, and its consumption has become a cultural norm spanning all age categories and societal levels. Mbui [7] states that tea supports livelihoods in Kenya and is the country's top foreign exchange income, contributing about 4% to the gross domestic product (GDP) [8].

Kenya leads in tea exports by volume but ranks second in earnings after Sri Lanka [9]. In 2019, Kenya's tea exports amounted to 497 million kilograms, generating US$1.17 billion, while Sri Lanka, with 300 million kilograms, earned US$1.24 billion. This considerable revenue difference represents a significant loss for Kenya and has adverse effects on the players in its tea subsector industry [10]. EATTA [11] indicated that Kenya makes less from tea exports than Sri Lanka because it mainly exports primary processed tea, while Sri Lanka exports value-added tea. This situation continues to persist today. Adopting Sri Lanka's supply chain practice (SCP) and achieving an identical price of US$4.10/kg in 2019 could have improved Kenya's earnings to US$2.037 billion from US$1.17 billion at that time. Implementing advanced SCP can increase earnings and profits for the tea industry, generating jobs and improving the country's GDP [12].

Several studies have examined the gaps regarding the impact of SCMP on the performance of Kenya's tea subsector industry. For instance, Ondieki and Oteki [13] studied the impact of supplier relationships on SCM in Kenya's Ministry of Finance but didn't analyze each independent parameter's impact on the dependent parameter. Their approach led to uncertain findings, making it hard to quantify the contribution of each parameter. Barasa, et al. [14] examined how SCMP impact the performance of steel manufacturing companies in Kenya. However, the study did not definitively specify which SCP would be most effective for individual firms, considering their diverse contexts. Additionally, the focus on the steel manufacturing sector has distinct SC goals compared to the tea subsector. Namusonge [15] studied how SC abilities influence the performance of Kenyan manufacturing entities but didn't specify whether these abilities affected operational performance. This lack of clarity, coupled with the focus on a sector with distinct goals from the tea subsector industry. Okello and Were [16] examined how SCMP affect the performance of food manufacturing companies listed on the Nairobi securities exchange. However, they did not explain why they focused solely on listed firms, which may bias the sample and limit the applicability of their findings to the broader food and beverage industry in Kenya, creating a gap in research. Aburi [17] studied Chai Trading Limited’s strategies to enter the Middle East markets but didn’t gather data from the global or target markets. This limits the findings to a Kenyan perspective. Kagira, et al. [18] analyzed strategies to address challenges in Kenya’s smallholder tea sector, proposing solutions based on SCMP for competitive advantage. However, they did not thoroughly evaluate specific practices to enhance sector performance. Ngatia [19] studied SCMP and performance in Kenya Tea Development Agency (KTDA)-managed factories. However, the study lacked indicators for each absolute parameter, used only one respondent per factory, and had too many independent parameters, limiting the analysis. Mbui [7] examined the impact of tactical management practices on export value addition in Kenya’s tea subsector. However, the study did not explain how these practices are connected to export value addition, nor did it specify which practices were suitable for each firm. The existing studies have mainly emphasized the role of SCMP in overall performance, often across various industries with distinct characteristics. However, there is a clear need for more targeted research specifically focusing on the tea subsector industry in Kenya. Such research would offer insights based on the experiences and performance of this industry, shedding light on the potential SCMP’ impact.

Our study aims to assess the SCMP impact on the performance of Kenya’s tea subsector industry using a recent developed FullEX method. Our specific objectives aim to assess the impact of supplier relationship management practice (SRMP), value chain management practice (VCMP), customer relationship management practice (CRMP), logistic management practice (LMP), supply chain integration (SCI) on the performance of of Kenya’s tea subsector industry.

This research contributes in the following ways.

a) Applying the FullEX method to evaluate the SCMP impact on the performance of Kenya’s tea subsector industry.
b) Identifying the most impactful practices among SRMP, VCMP, CRMP, LMP, and SCI on the performance of Kenya’s tea subsector industry.
c) Determining the factors that most significantly affect the performance of Kenya’s tea subsector industry within each of the five categories.

Previous studies on Kenya’s tea subsector industry have identified a lack of information on how SCMP impact its performance. There is a research gap in conducting a thorough study that combines both managerial and qualitative approaches to address this evaluation. This study aims to bridge this gap by applying the FullEX method. It intends to assist manufacturing organizations in improving their efficiency, help suppliers understand the industry’s operations, provide insights for academicians and researchers, offer concrete information for policymakers, enhance knowledge for SC professionals, and ultimately benefit the entire community and farmers in Kenya’s tea subsector industry.

The approaches to weight criteria depend on the subjective opinions of decision-makers (DMs) [20-25]. The analytical hierarchy process (AHP) [26, 27], the stepwise weight assessment ratio analysis (SWARA) [28, 29], the best worst method (BWM) [30], and the full consistency method (FUCOM) [31, 32] are some of these approaches which incorporate the personal viewpoints of DMs and assess each criterion in relation to others via pairwise comparisons (PCs). The AHP method leverages experts' ideas to conduct PCs [33-35]. By converting these ideas into numerical values (1–9-point scale), the significance of each criterion is determined by the method. Conversely, the SWARA method removes criteria with approximately low significance and ranks those that are most significant [36]. The BWM is utilized when there are no objective measures accessible to evaluate criteria [37]. It is centered around comparing pairs of criteria using best and worst references, which helps reduce the impact of anchoring bias [38]. The FUCOM method involves comparing each criterion with every other criterion using decimal/integer scale in n-1 PCs [39]. The FullEX technique sets itself apart from other subjective approaches by factoring in the esteem of the expert, which includes their education level and years of experience. This initial step is pivotal in making decisions, as these experts assess and prioritize criteria based on their significance. More knowledgeable experts are likely to make more accurate decisions, while a higher education level suggests a stronger conceptual foundation for making decisions. Unlike other subjective methods, these two crucial parameters have not been considered by them in the procedure of making decision. The FullEX method combines Fuller's technique with expert reputation, illustrating how an expert's education and experience can remarkably impact the final decision. Unlike the BWM, FullEX produces varying rankings based on experts, while the BWM's results remain consistent regardless of expert reputation. Therefore, FullEX not only justifies its approach but also paves the way for new ideas in subjective approaches. However, there is a gap in research regarding the application of FullEX to evaluate the impacts of SCMP on the performance of the tea sub sector. This study addresses this gap by using FullEX for this evaluation.

The rest of the paper is organized as follows: **Section 2:** Literature review, **3** Methodology, **4** Application, **5** Results and validation, **6** Comparative analysis, **7** Discussion and findings, **8** Managerial implications, **9** Conclusions and future recommendations.

2. LITERATURE REVIEW

This section includes three sub-sections.

2.1. Overview of approaches related to the SCMP related studies

Studies on SCMP have been conducted in various countries globally [40-42]. For instance, Mathivathanan, et al. [43] examined how 25 SSCM practices were chosen across three prominent Indian manufacturing sectors. Mastos and Gotzamani [44] proposed a provable model for SSCM in the food industry. Stević, et al. [21] investigated the factors leading to breakdowns in SCM for manufacturing companies. Farbod, et al. [45] explored the impact of supply chain dynamics and flexibility on financial performance, mediated by supply chain resilience. Aliahmadi, et al. [46] assessed how artificial intelligence of Things (AIoT)-based supply chain technologies affect equity by analyzing their various dimensions and components. Rezaee and Pilevari [47] proposed a sustainable multi-tier supply chain model for power plant products. Ekram Nosratian and Taghavi Fard [48] examined the impact of information sharing on supply chain performance. Khan, et al. [49] examined existing trends, emerging developments, and future research avenues in SSCM. Mardani, et al. [50] extensively reviewed the structural equation approach usage to evaluate sustainable and green SCMP. Baliga, et al. [51] explored the factors affecting SSCM practices and their performance implications. Yazdani, et al. [52] studied the parameters impacting flood risk and their effects on the resilience of an agricultural SC. Goodarzian, et al. [53] delineated the key factors affecting the adoption of block chain in SCM.

2.2. Implementation of MCDM on SCMP related studies

MCDM methods are effective decision-making tools, widely utilized in the SSCM field due to their ability to manage multiple criteria efficiently. For instance, Bahrampour, et al. [54] introduced a nonlinear mixed-integer model for designing a sustainable closed-loop supply chain, considering all three sustainability dimensions. Singh, et al. [55] analyzed the barriers hindering the implementation of blockchain in construction supply chain management. Banihashemi, et al. [56] explored the main challenges and barriers to green supply chain management in the construction industry. Ghasempoor Anaraki, et al. [57] proposed a new method for assessing and rating suppliers. Farnam and Darehmiraki [58] modeled a supply chain management problem in a fuzzy environment. Tsai, et al. [59] proposed unique methodologies for evaluating green SCM practices. Büyüközkan and Güler [60] presented an analytical tool for SC assessment in a logistics company. Rostamzadeh, et al. [61] developed a quantitative model to measure unpredictability in GSCM activities. Goli and Mohammadi [62] presented an innovative approach for evaluating the SC performance, with a focus on its sustainability approaches. Heidary Dahooie, et al. [63] developed a framework for prioritizing SSCM practices. Pamucar, et al. [64] devised a strategy to address supplier selection challenges during the COVID-19 pandemic. **Table 1** illustrates the utilization of MCDM methods in the SSCM domain.

Table 1: Application of MCDM methods to SSCM related studies

Source	Focus	GDM	CA	Methodology
Bahrampour, et al. [54]	Supply chain network design	No	No	Metaheuristic algorithm
Singh, et al. [55]	Barrier identification in the adoption of blokchain in SCM	Yes	Yes	PF-DEMATEL
Banihashemi, et al. [56]	GSCM barrier evaluation	Yes	Yes	F-BWM
Ghasempoor Anaraki, et al. [57]	Supply chain supplier assessment and choice	Yes	Yes	SMART, DEMATEL, ANP
Farnam and Darehmiraki [58]	Supply chain management issue model	Yes	No	HFLP
Tsai, et al. [59]	GSCMP assessment	Yes	No	DEMATEL, ANP
Büyüközkan and Güler [60]	Supply chain analytic (SCA) tool assessment	Yes	No	HFLTS, AHP, MULTIMOORA
Goli and Mohammadi [62]	Petrochemical SC	Yes	No	SV, BSC, PA, MULTIMOORA

Heidary Dahooie, et al. [63]	SSCMP ranking	Yes	No	DELPHI, DEMATEL
Pamucar, et al. [64]	Supplier selection in healthcare SCM	Yes	Yes	FRN, MACBETH, CODAS
Our study	Assessment of the impact of SCMP on the performance of tea sub-sector	Yes	Yes	FullEX

Note: AHP- Analytic Hierarchy Process; ANP- Analytic Network Process; BWM- Best Worst Method; CA-Comparative Analysis; CODAS- Combinative Distance based Assessment; DEMATEL- Decision-Making Trial Evaluation Laboratory; FRN- Fuzzy Rough Number; GDM-Group Decision Making; HFLTS- Hesitant Fuzzy Linguistic Term Set; MACBETH- Measuring attractiveness through a categorical-based evaluation technique; MULTIMOORA- Multi-Objective Optimization by Ration Analysis and the Full Multiplicative Form; SMART- Simple Multi-Attribute Rating Technique.

2.3. Research gaps

Below are the identified research gaps: a) The yet unexplored and unaddressed impacts of SCMP on the performance of Kenya's tea sub-sector from the perspective of MCDM. This study, the first of its kind, seeks to uncover these impacts; b) The lack of an extensive framework applying the FullEX method to evaluate how SCMP influences the performance of the tea sub-sector.

3. FULLEX APPROACH

The FullEX method, as introduced by Bošković, et al. [65] for sustainable last-mile delivery courier selection, provides a unique approach by systematically evaluating decision-making criteria through expert assessments. Notably, this method considers the influence of experts' opinions based on their education degree and experience. The FullEX method is performed in nine steps. These steps are as follows:

Step 1. Input data matrix formulation is shown in Table A1 in appendix.

Fuller's method, a recognized approach for assessing criteria importance, involves paired comparisons, where experts evaluate two criteria at a time, determining the more significant one in each pair. When employing Fuller's method to input data, experts indicate their preference for one criterion over another.

Step 2. Expert's recognition calculation

The triangular shape results from gradual criteria comparison, omitting the previously compared criterion in each step. To calculate expert reputations, the first step involves determining the competence level (L_i) by considering years of experience and educational degrees.

$$L_i = \frac{YE_i + ED_i}{2}, i = 1, 2, \ldots, q, \tag{1}$$

Here, $YE_i -$ Years of experience for the i-th expert, and $ED_i -$ the educational degree of the i-th expert. Concerning educational degrees, a one-to-three-point scale is adopted, with one denoting a bachelor's degree, two for a master's degree, and three for a Ph.D. After assessing each expert's competence level, the reputation of the i-th expert is calculated using the provided equation.

$$W^{Ei} = \frac{L_i}{\sum_{i=1}^{q} E_i}, i = 1, 2, \ldots, q. \tag{2}$$

Step 3. Input-data matrix normalization.

Once the input data matrix is established, the process of data normalization is initiated. This involves the application of the normalization technique described by Equation (3) and illustrated in Table A2 in appendix.

$$v_{ij} = \frac{x_{ij}}{\sum_{i=1}^{q} x_{ij}}, i = 1, 2, \ldots, q, j = 1, 2, \ldots, p. \tag{3}$$

Step 4. Obtain the expert-weighted normalized input-data matrix.

In this phase, the normalized input data undergoes multiplication by the experts' significance, computed in Step 2 according to Equation (4) and outlined in Table A3 in appendix.

$$r_{ij} = v_{ij} \cdot W^{Ei}, i = 1, 2, \ldots, q, j = 1, 2, \ldots, p. \tag{4}$$

Step 5. Identify an optimal value for each criterion.

The main objective of this step is to determine the optimal value ($V_{j\,max}$) for each criterion within columns. This is computed using Equation (5) and displayed in Table A4 in appendix.

$$V_{j\,max} = \max_{i=1,2,\ldots,q} r_{ij}, j = 1, 2, \ldots, p. \tag{5}$$

Step 6. Obtain the optimal decision-making matrix.

In this step, each element in the expert-weighted normalized matrix is divided by its corresponding optimal value ($V_{j\,max}$), determined through Equation (6) and depicted in Table A5 in appendix.

$$y_{ij} = \frac{r_{ij}}{V_{j\,max}}, i = 1, 2, \ldots, q, j = 1, 2, \ldots, p. \tag{6}$$

Step 7. Summarize all the values by columns in the optimal decision-making matrix.

$$K_j = \sum_{i=1}^{q} y_{ij}, \ i = 1, 2, \ldots q, j = 1, 2, \ldots, p. \tag{7}$$

Step 8. Apply the final ranking.

During this phase, the importance of criteria (F_j) is calculated as follows:

$$F_j = \frac{K_j}{\sum_{j=1}^{p} K_j}, i = 1, 2, \ldots q, j = 1, 2, \ldots, p. \tag{8}$$

Step 9. Consistency index calculation

Concerning subjective methods, such as the FullEX method in this context, ensuring the reliability of expert responses is crucial. While the AHP method employs a well-established approach to measure inconsistency rates, where a rate below 0.1 indicates reliability, the FullEX method necessitates a different approach [66]. In this case, the consistency index (CI) is utilized, involving a second round of interviews with experts who are unaware of the initial round's results regarding the assessed criteria. During this second round, experts assign percentage importance scores (from 0 to 100%) to each criterion, ensuring a cumulative sum of 100% for all "n" criteria. By comparing the results from both rounds, the decision-maker can draw conclusions regarding the reliability of the outcomes. If the responses from the second round are denoted as P_j and the previously derived FullEX weights as (F_j), the consistency index (CI) can be calculated using Equation (9).

$$\mathrm{CI} = \frac{\sum_{j=1}^{n} |F_j * 100 - P_j|}{100} \tag{9}$$

If CI is below 0.1, the findings are deemed reliable. Conversely, experts should reevaluate the criteria assessment process if the CI exceeds this threshold. In summary, CI below 0.1 indicates satisfactory consistency.

4. CASE STUDY APPLICATION

A case study was undertaken to assess the efficacy of the FullEX method. The primary objective of this study was to assess the SCMP impact on the performance of Kenya's tea subsector industry. Initially, the study identified an expert group comprising three supply chain professionals involved in tea subsector industry, with their background information indicated in Table 2. The SCMP were categorized into two levels as shown in Table 3.

Table 2: Background Information of Experts

Experts (Es)	Years of experience	Education degree
E_1	22	3
E_2	7	2
E_3	20	1

Table 3: Two Levels of SCMP

Level-1	Level-2	References
Supplier relationship management practice (**C1**)	Collaborative initiatives (C11)	[18, 67, 68]
	Planning and forecasting initiatives (C12)	
	Coordination of resources sharing initiatives (C13)	
Value chain management practice (**C2**)	Product diversification (C21)	[18, 67, 68]
	Product innovation (C22)	
	Product process management (C23)	
Customer relationship management practice (**C3**)	Customer product value satisfaction level (C31)	[18, 67, 68]
	Customer product design input (C32)	
	Customer communication channels (C33)	
Logistics management practice (**C4**)	Transport management systems (C41)	[67, 68]
	Inventory management systems (C42)	
	Distribution channel networks (C43)	
Supply chain integration (**C5**)	Individual integration (C51)	[67, 68]
	Internal integration (C52)	
	External integration (C53)	

5. RESULTS AND VALIDATION ANALYSIS

In the initial phase, experts utilize Fuller's triangle principle to assess two criteria, identifying the superior one according to their judgment.

Step 1. Upon completion of the experts' assessment, the input data matrix for the level-1 variable is developed and showcased in Table 4.

Table 4: Input-data Matrix

Experts/Criteria	C1	C2	C3	C4	C5
E_1	1	4	3	0	2
E_2	1	2	4	1	2
E_3	2	3	4	1	0

SUM	4	9	11	2	4

Step 2. Once the input data matrix, serving as the initial prerequisite for subsequent calculations of criteria importance, has been formulated, the expert assessment is then presented, as depicted in Figure 1.

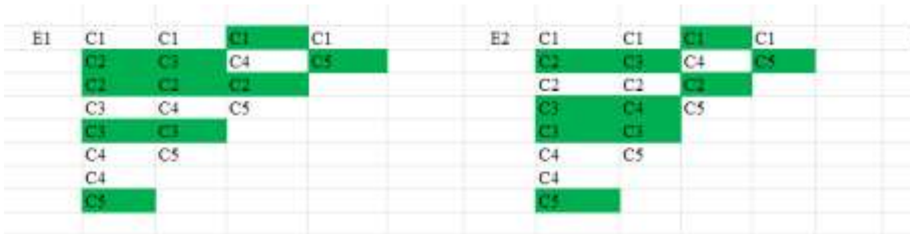


Figure 1: Expert assessment.

Note: 1, 2, 3…., n denotes expert's numbers.

Step 3 and step 4. The input data normalization, performed with the expert weighted matrix, is calculated according to Equations (6) and (7), and the outcomes are displayed in Tables 5 and 6, respectively.

Table 5: Normalized input-data Matrix

Experts/Criteria	C1	C2	C3	C4	C5
E_1	0.250	0.444	0.272	0.000	0.500
E_2	0.250	0.222	0.363	0.500	0.500
E_3	0.500	0.333	0.363	0.500	0.000

Step 5 and step 6. To derive the optimal decision-making matrix (see **Table 7**), each element of the expert-weighted normalized input data matrix is divided by its corresponding optimal value (V_{jmax}).

Table 6: Expert-weighted normalized input-data matrix

Experts/Criteria	C1	C2	C3	C4	C5
E_1	0.113	0.202	0.124	0.000	0.227
E_2	0.040	0.036	0.059	0.081	0.081
E_3	0.190	0.127	0.138	0.190	0.000
V_{jmax}	0.190	0.202	0.138	0.190	0.227

Table 7: Optimal decision-making matrix

Experts/Criteria	C1	C2	C3	C4	C5
E_1	0.595	1.000	0.893	0.000	1.000
E_2	0.214	0.179	0.428	0.428	0.359
E_3	1.000	0.629	1.000	1.000	0.000

Step 7 and step 8. The optimal decision-making matrix consolidates all values, enabling the calculation of the final importance of criteria. Using Equation (8), the final criteria weights (F_j) are computed and illustrated in Figure 2.

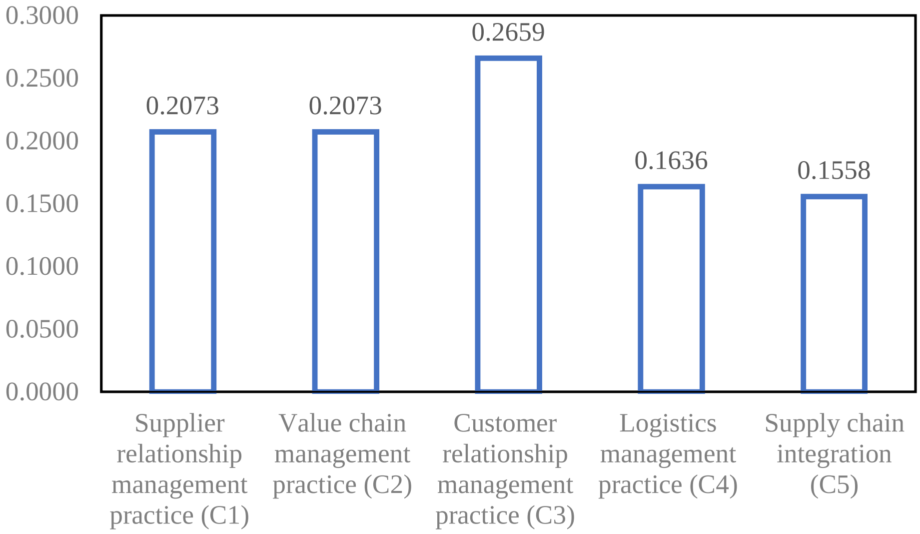


Figure 2: Level-1 variable ranking

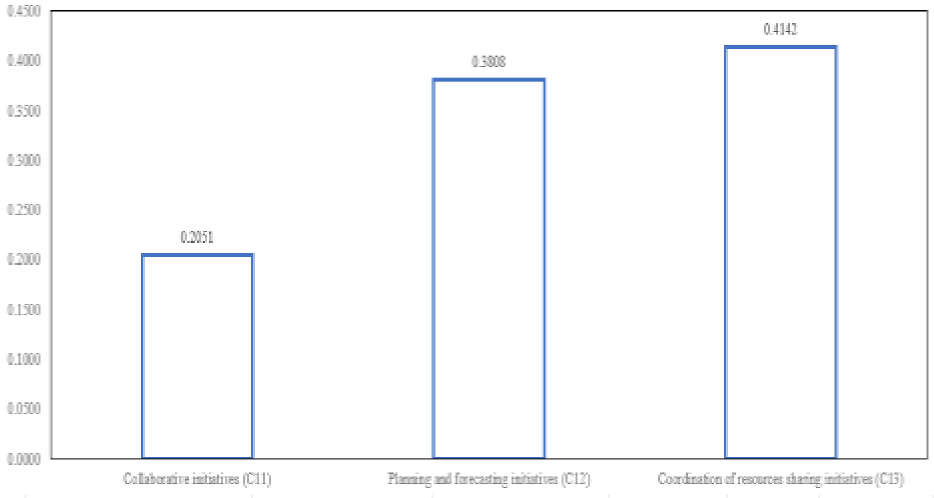
According to the FullEX approach, the customer relationship management (C3) practice emerges as the most influential variable affecting the performance of the tea sub-sector in Kenya, based on the criteria weights. The rankings of others are as follows: C1 = C2 > C4 > C5.

Step 9. To affirm the reliability of the findings, a subsequent round of interviews with experts was conducted to gather data on the percentage distribution of criteria significance. As illustrated in Table 8, the results indicate a consistency rate below 0.1 (CI = 0.041), suggesting a satisfactory level of reliability

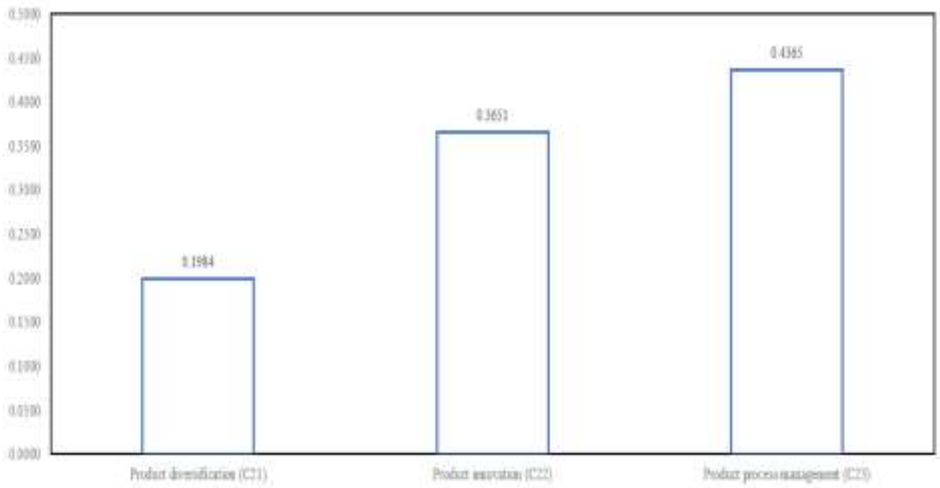
Table 8: CI calculation

	L_j	E_1	E_2	E_3	Average P_j	$\left\lvert F_J * 100 - P_j \right\rvert$	CI
C1	0.207	20	20	20	20.00	0.730	0.007
C2	0.207	20	25	20	21.67	0.934	0.009
C3	0.266	30	30	20	26.67	0.072	0.001
C4	0.164	15	10	20	15.00	1.364	0.013
C5	0.156	15	15	20	16.67	1.088	0.011
							0.041

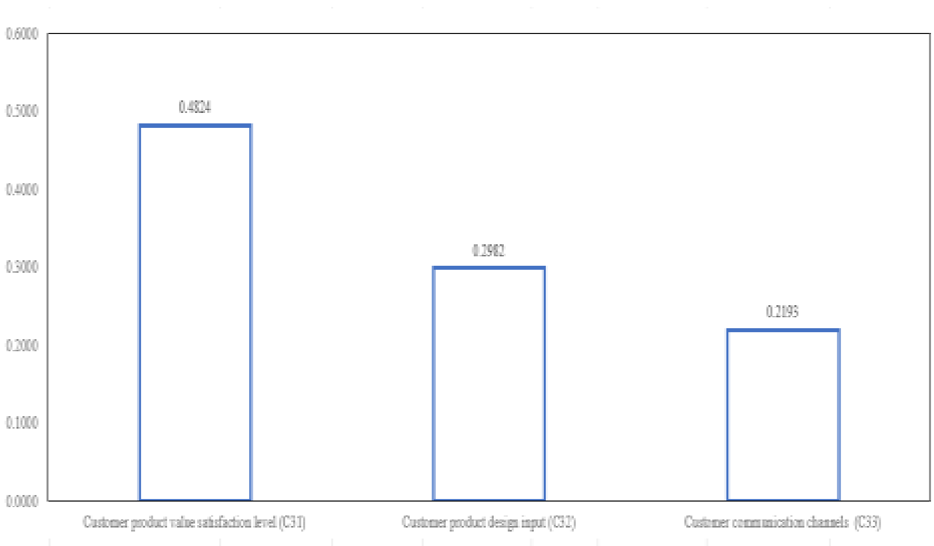
Following that, the same panel of experts was engaged to evaluate the inner levels (Level -2) of influential variables. For this purpose, identical procedures were employed, mirroring the steps utilized previously (see Tables A6 to A10 in appendix). According to the FullEX approach and based on the results from Figure 3, the coordination of resources sharing initiatives (C13), the product process management (C23), the customer product value satisfaction level (C31), the distribution channel networks (C43), and the internal integration (C52) are the most significant SCMPs affecting the performance of the tea sub sector in Kenya under level-2 variables.



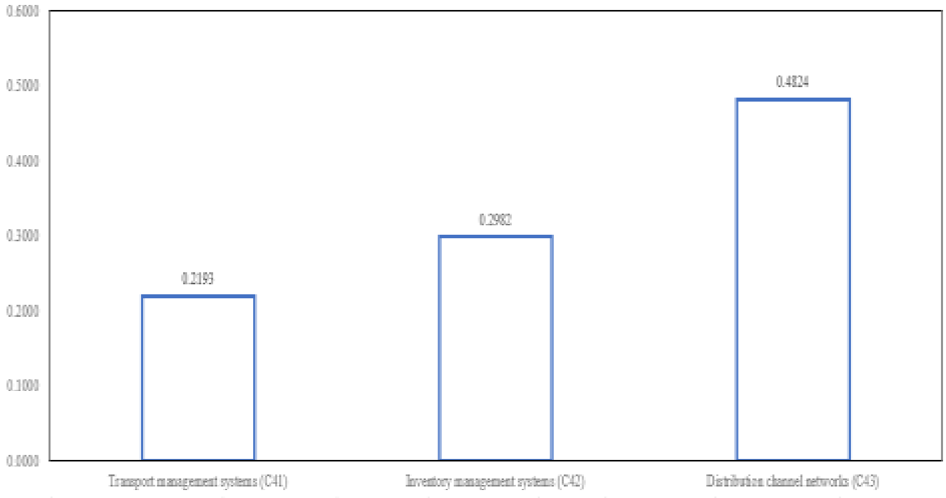
(a)



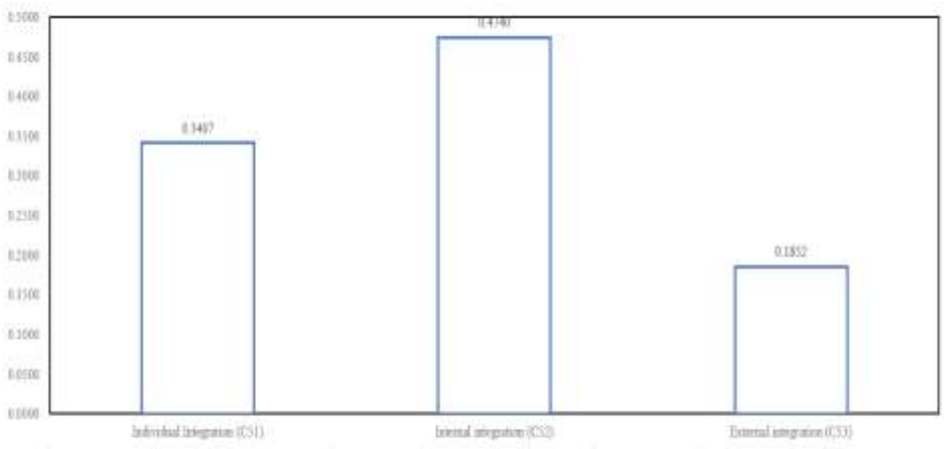
(b)


0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
0.4824
0.2982
0.2193
Customer product value satisfaction level (C31)
Customer product design input (C32)
Customer communication channels (C33)

(c)


0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
0.2193
0.2982
0.4824
Transport management systems (C41)
Inventory management systems (C42)
Distribution channel networks (C43)

(d)



(e)

Figure 3: Level 2 variable ranking: (a) Supplier relationship management practice; (**b**) Value chain management practice; (**c**) Customer relationship management practice; (**d**) Logistics management practice; (**e**) Supply chain integration.

6. COMPARATIVE ANALYSIS

Comparative analyses are conducted to check the outcomes of criteria weighting generated by the FullEX method with those of other techniques. Two distinct weighting approaches, BWM and AHP, are employed for criteria weights and subsequently compared. AHP utilizes expert opinions for pairwise comparisons, converting them into numerical values to evaluate criterion importance. BWM is utilized in the absence of objective metrics, relying on Best-Worst pairwise comparisons. FullEX, a novel method, integrates experts' education level and experience, distinguishing it from AHP and BWM. Additionally, it introduces a unique calculation for consistency ratio, enhancing its distinctiveness among subjective methods. The calculations derived from expert opinions in this research have produced results for each of the methods. The rankings of criteria are depicted in Table 9.

Table 9: Comparative Analysis Outcomes

Levels	Methods	Rank	The most significant criterion	The least significant criterion
Level-1	FullEX	$C3 > C2 = C1 > C4 > C5$	C3	C5
	BWM	$C3 > C2 > C1 > C4 > C5$		
	AHP	$C3 > C2 > C1 > C4 > C5$		
	FullEX	$C13 > C12 > C11$	C13	C11
	BWM	$C13 > C12 > C11$		
	AHP	$C13 > C12 > C11$		
	FullEX	$C23 > C22 > C21$	C23	C21

	BWM	$C23 > C22 > C21$		
	AHP	$C23 > C22 > C21$		
	FullEX	$C31 > C32 > C33$	C31	C33
Level-2	BWM	$C31 > C32 > C33$		
	AHP	$C31 > C32 > C33$		
	FullEX	$C43 > C42 > C41$	C43	C41
	BWM	$C43 > C42 > C41$		
	AHP	$C43 > C42 > C41$		
	FullEX	$C52 > C51 > C53$	C52	C53
	BWM	$C52 > C51 > C53$		
	AHP	$C52 > C51 > C53$		

Based on these findings, the criteria weight outcomes from the FullEX method were entirely congruent with those from both the BWM and AHP methods. Consequently, the comparative analysis outcomes validate the alignment of the FullEX method with other criteria weighting methodologies.

7. DISCUSSIONS AND FINDINGS

Based on prior research and expert insights, it is clear that numerous SCMP influence the performance of Kenya's tea sub-sector. To assess their impact, a FullEX methodology was utilized to ascertain the objective weights of these practices.

The findings underscore the utmost importance of "customer relationship management practice" as the primary SCMP under level 1, with a weight of 0.266. This aligns with Oyedijo [69] emphasis on active customer engagement, adapting to customer values, and addressing evolving needs across various life domains. Oyedijo [69] also highlights proactive customer business development and building cooperation for mutual value creation. According to Schmenner [70], customer relationship management encompasses diverse practices aimed at addressing concerns, fostering lasting relationships, and enhancing overall satisfaction. While Mukwate Ngui-Muchai and Muchai Muniu [71] indicates that CRMP involves integrating supply chain functions, sales, customer service, and marketing to deliver superior value, Ali [72] views it as a main business strategy for delivering tailored services.

The coordination of resource-sharing initiatives is identified as the primary factor within the SRMP for Kenya's tea sector, a finding that corroborates the research by Buranasiri, et al. [73]. This prominence is attributed to several key factors. Firstly, the sector heavily relies on a network of suppliers for crucial resources, such as raw materials and labor. Effective coordination ensures timely access to these resources, minimizing disruptions in production. Additionally, given the complexity of the tea supply chain in Kenya, involving multiple stakeholders from smallholder farmers to large-scale processors and exporters, coordination is essential to streamline interactions among these diverse entities, enhancing efficiency and reducing costs. Furthermore, coordination facilitates standardized processes and quality control measures, ensuring consistent quality across the supply chain, which is crucial for the sector's reputation and competitiveness. Moreover, in a sector prone to various risks such as market fluctuations and weather-related challenges, coordinating resources enables proactive risk management strategies to be developed and implemented, enhancing the sector's resilience. Finally, effective coordination fosters trust and collaboration with suppliers, supporting the establishment of long-term, mutually beneficial partnerships that contribute to the sector's sustainability and growth.

Product process management is recognized as the primary factor within the value chain management practice for Kenya's tea sector, a finding that corroborates the research by Bedford, et al. [74]. Firstly, the tea industry in Kenya involves various stages of processing, from cultivation to packaging and distribution. Effective management of these processes is essential for ensuring product quality, consistency, and compliance with industry standards. Additionally, optimizing product processes helps to streamline operations, reduce waste, and enhance efficiency throughout the value chain. Moreover, in a competitive market environment, efficient product process management enables tea producers to meet consumer demands, adapt to market trends, and maintain a competitive edge. Furthermore, by focusing on product process management, stakeholders in the tea sector can identify opportunities for innovation, value addition, and cost reduction, thus contributing to overall profitability and sustainability.

The significance of customer product value satisfaction within customer relationship management practices is underscored by Matuga [67] findings, emphasizing its crucial role in maintaining competitiveness. Prioritizing this aspect ensures that businesses can meet customer expectations, foster loyalty, and ultimately thrive in competitive markets like the Kenyan tea sector. Satisfied customers not only drive repeat business and foster brand loyalty but also contribute to positive brand reputation and reduced customer churn. By delivering superior value and monitoring customer feedback, companies can differentiate themselves in the market, improve their offerings, and ultimately ensure long-term success in the industry.

In the tea sector, the pivotal role of the distribution channel networks in logistics management is underscored by Matuga [67] who showed that these networks ensure timely distribution, cost-effective transportation, and quality control throughout the supply chain. By establishing effective distribution channels, tea producers can maximize market reach, adapt to changing demand, and forge valuable partnerships with distributors and retailers. Furthermore, these networks provide valuable market insights, enabling producers to stay informed about consumer preferences and market trends.

The findings regarding Kenya's tea sector echo research by Flynn, et al. [75], emphasizing the pivotal role of internal integration in SCM. They posit that successful SCM hinges on robust internal integration, with companies achieving higher levels of external integration by prioritizing this aspect. Lee, et al. [76] further emphasize that internal integration is key to containing costs, while integration with suppliers enhances overall supply chain reliability and performance. Since the inception of supply chain literature, scholars have explored the potential of supply chain integration as a competitive business strategy. These insights underscore the significance of fostering internal cohesion within the supply chain to drive efficiency, reliability, and competitiveness in Kenya's tea sector and beyond.

8. MANAGERIAL IMPLICATIONS

The findings of this study offer numerous managerial insights.

The study highlights customer relationship management as the primary factor influencing the performance of Kenya's tea sub-sector. Secondary factors include coordinating resource-sharing initiatives, managing product processes, ensuring customer satisfaction with product value, optimizing distribution channel networks, and enhancing internal integration. This research provides valuable insights for different stakeholders. It offers valuable information to tea manufacturing organization managers, aiding them in improving the efficiency and effectiveness of their operations. Ultimately, this can result in enhanced industry performance and profitability. The study can assist suppliers in comprehending the operational dynamics of the tea subsector industry, particularly in terms of SCM. This understanding will empower them to better plan their own operations. Scholars and researchers stand to gain from this study as it offers deeper insights into SCM, particularly within the context of Kenya. Given Kenya's prominent position as one of Africa's top tea exporters, contributing substantially to the country's revenue, conducting research on SCMPs in the Kenyan tea subsector becomes crucial. This study holds substantial value for policymakers within the Kenyan tea subsector industry. It furnishes tangible insights into SCMPs and offers specific approaches tailored to the Kenyan context. Policymakers, notably those within the Ministry of Agriculture and the Tea Board of Kenya, can leverage the study's findings to scrutinize key SCM issues and craft pertinent policies. The SC professionals can gain new insights into evolving SCMPs, particularly in addressing industry challenges. The study holds promise for the entire community and tea farmers engaged in Kenya's tea subsector industry. By optimizing SC operations and minimizing inefficiencies, additional funds can be allocated to other financially beneficial tea development research projects, ultimately benefiting both the community and the farmers economically.

9. CONCLUSIONS AND FUTURE RECOMMENDATIONS

This study pioneers the use of the FullEX technique to evaluate the impacts of SCMPs in the performance of tea sub-sector. It is aims to helps managers and suppliers in tea manufacturing, scholars, researchers, policymakers in tea subsector, the wider community, and tea farmers engaged in the industry. Additionally, the study evaluate these impacts based on the years of experience and education background of experts, an initial step which is pivotal in making decisions. This study showcases the technique's real efficacy by applying it to a Kenyan case study. The research identifies that while customer relationship management is the primary driver of performance in Kenya's tea subsector, additional factors include coordinating resource-sharing initiatives, managing product processes, ensuring customer satisfaction with product value, optimizing distribution channel networks, and enhancing internal integration. Our study, while impactful, faces certain constraints. Firstly, focusing solely on Kenya may restrict the applicability of our findings, highlighting the necessity for future research to explore broader contexts. Secondly, the FullEX technique presents two limitations: its outcomes may vary depending on the expertise of individuals across different domains, and it is confined to precise values. To address these limitations, future research should: first, extend this methodology to uncertain environments such as fuzzy, neutrosophic, and spherical sets; second, include more experts from diverse backgrounds in the study; and third, consider additional factors that could affect the performance of Kenya's tea subsector industry, such as warehouse management systems, electronic supply chain management, supplier training management, and communication systems.

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APPENDIX

Table A1: Input data matrix

Experts/Criteria	C_1	C_1	...	C_j	...	C_p
E_1	x_{11}	x_{12}	…	x_{1j}	…	x_{1p}
E_1	x_{21}	x_{22}	…	x_{2j}	…	x_{2p}
…	…	…	…	…	…	…
E_i	x_{i1}	x_{i2}	…	x_{ij}	…	x_{ip}
…	…	…	…	…	…	…
E_q	x_{q1}	x_{q2}	…	x_{qj}	…	x_{qp}

where E_1, E_2, …, E_q are experts and q is the number of experts, C_1, C_2, …, C_p are criteria and p is the number of criteria, and x_{ij} are the experts' criteria importance assessments based on Fuller's triangle.

Table A2: Input-data matrix normalization

Experts/Criteria	C_1	C_1	…	C_j	…	C_p
E_1	v_{11}	v_{12}	…	v_{1j}	…	v_{1p}
E_1	v_{21}	v_{22}	…	v_{2j}	…	v_{2p}
…	…	…	…	…	…	…
E_i	v_{i1}	v_{i2}	…	v_{ij}	…	v_{ip}
…	…	…	…	…	…	…
E_q	v_{q1}	v_{q2}	…	v_{qj}	…	v_{qp}

Table A3: Expert-weighted normalized input-data matrix

Experts/Criteria	C_1	C_1	…	C_j	…	C_p
E_1	r_{11}	r_{12}	…	r_{1j}	…	r_{1p}
E_1	r_{12}	r_{22}	…	r_{2j}	…	r_{2p}
…	…	…	…	…	…	…
E_i	r_{i1}	r_{i2}	…	r_{ij}	…	r_{ip}
…	…	…	…	…	…	…

E_q	r_{q1}	r_{q2}	…	r_{qj}	…	r_{qp}

Table A4: Optimal value for each criterion in the matrix of expert-weighted normalized input data ($V_{j\,max}$)

Experts/Criteria	C_1	C_1	…	C_j	…	C_p
E_1	r_{11}	r_{12}	…	r_{1j}	…	r_{1p}
E_1	r_{21}	r_{22}	…	r_{2j}	…	r_{2p}
…	…	…	…	…	…	…
E_i	r_{i1}	r_{i2}	…	r_{ij}	…	r_{ip}
…	…	…	…	…	…	…
E_q	r_{q1}	r_{q2}	…	r_{qj}	…	r_{qp}
V_{jmax}	V_{1max}	V_{2max}	…	V_{jmax}	…	V_{pmax}

Table A5: Optimal decision-making matrix

Experts/Criteria	C_1	C_1	…	C_j	…	C_p
E_1	y_{11}	y_{12}	…	y_{1j}	…	y_{1p}
E_1	y_{21}	y_{22}	…	y_{2j}	…	y_{2p}
…	…	…	…	…	…	…
E_i	y_{i1}	y_{i2}	…	y_{ij}	…	y_{ip}
…	…	…	…	…	…	…
E_q	y_{q1}	y_{q2}	…	y_{qj}	…	y_{qp}

Table A6: Input data matrix for level-2 variables

Experts/Criteria	C11	C12	C13	C21	C22	C23	C31	C32	C33
E_1	1	0	2	0	1	2	2	1	0
E_2	0	2	1	1	0	2	2	1	0
E_3	0	1	2	0	1	2	2	0	1
Sum	1	3	5	1	2	6	6	2	1
Experts/Criteria	C41	C42	C43	C51	C52	C53			
E_1	0	2	1	2	1	0			
E_2	0	2	1	0	2	1			
E_3	2	0	1	2	1	0			
Sum	2	4	3	4	4	1			

Table A7: Normalized input data matrix for level-2 variables

Experts/Criteria	C11	C12	C13	C21	C22	C23	C31	C32	C33
E_1	1.000	0.000	0.400	0.000	0.500	0.333	0.333	0.500	0.000
E_2	0.000	0.667	0.200	1.000	0.000	0.333	0.333	0.500	0.000
E_3	0.000	0.333	0.400	0.000	0.500	0.333	0.333	0.000	1.000
Experts/Criteria	C41	C42	C43	C51	C52	C53			
E_1	0.000	0.500	0.333	0.500	0.250	0.000			

E_2	0.000	0.500	0.333	0.000	0.500	1.000
E_3	1.000	0.000	0.333	0.500	0.250	0.000

Table A8: Expert-weighted normalized Input data matrix for level-2 variables

Experts/Criteria	C11	C12	C13	C21	C22	C23	C31	C32	C33
E_1	0.454	0.000	0.181	0.000	0.227	0.152	0.152	0.227	0.000
E_2	0.000	0.109	0.033	0.163	0.000	0.054	0.055	0.082	0.000
E_3	0.000	0.127	0.152	0.000	0.191	0.127	0.127	0.000	0.382

Experts/Criteria	C41	C42	C43	C51	C52	C53
E_1	0.000	0.227	0.152	0.227	0.114	0.000
E_2	0.000	0.082	0.055	0.000	0.082	0.164
E_3	0.382	0.227	0.127	0.191	0.114	0.000

Table A9: Optimal decision-making matrix for level-2 variables

Experts/Criteria	C11	C12	C13	C21	C22	C23	C31	C32	C33
E_1	1.000	0.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
E_2	0.000	0.857	0.179	1.000	0.000	0.359	0.360	0.360	0.000
E_3	0.000	1.000	0.839	0.000	0.839	0.839	0.840	0.000	1.000

Experts/Criteria	C41	C42	C43	C51	C52	C53
E_1	0.000	1.000	1.000	1.000	1.000	0.000
E_2	0.000	0.359	0.359	0.000	0.720	1.000
E_3	1.000	0.000	0.839	0.840	0.840	0.000

Table A10: CI calculation for level-2 variables

CI	C11	C12	C13	C21	C22	C23	C31	C32	C33
		0.061			0.064			0.069	

CI	C41	C42	C43	C51	C52	C53
		0.063			0.085	