

Developing a Composite Index for Evaluating the Efficiency of the Information Flow in FMCG Supply Chains in Sri Lankan Context

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Abstract: Information sharing has been considered as the most crucial aspect of supply chain decision making, integration, whereas literature acknowledged that efficient information sharing in supply chains has delivered extensive benefits and directly depends on the information flow efficiency. The need of evaluating the information flow efficiency was identified from the literature and this study distinctively focused on the Fast-Moving Consumer Goods (FMCG) supply chains in Sri Lanka and evaluating their information flow efficiency. Data was collected using a questionnaire survey and interviews with the FMCG industry experts. The study identified information flow efficiency contributing factors and developed the metrics linked to the factors, using statistical inference. The research concludes with developing an information flow efficiency index consist of information flow efficiency contributing factors using Principal Component Analysis (PCA) which can be used to evaluate, compare, and control the information flow efficiency in supply chains, thus identifying improvement opportunities and weaknesses.

Keywords: Information, Supply Chain Management, FMCG, Performance Measurement, PCA, Information Flow Efficiency

1. INTRODUCTION

The processes of sourcing the materials, manufacturing the products, and distribution to the customers can be simply identified as the supply chain (SC) of an organization. It can be elaborated as a network of all the activities involving sourcing, procurement, manufacturing, distribution, and all the related logistics activities (“SCM Definitions and Glossary of Terms,” n.d.).

A supply chain consists of three major flows: product flow, financial flow, and information flow. Among them, information flow is the most crucial function and the key aspect of supply chain decision making (Kolinski & Jaskolska, 2018) and in today’s global market, material flow and the financial flow are being closely dependent on the information flow (J. Wang & Zhuo, 2020).

Traditionally Supply Chain Management (SCM) was mainly focused on managing the material flow across the supply chain and it did not necessarily focused enough on information sharing (Arshinder *et al.*, 2008). After the third industrial revolution, the development of the information age was triggered. Industries were very much dependent on information sharing and it changed the way how goods and services were produced (Brian, 2015).

Especially in the Fast Moving Consumer Goods (FMCG) industry, with strategies and advanced technologies like digitalization, Big Data Analytics, and Industry 4.0, data/

information generated by billions of digitized devices is to be efficiently managed, analyzed, shared, and stored (G. Wang, Gunasekaran, Ngai, & Papadopoulos, 2016).

According to Yu *et al.* (2020), organizations have acquired numerous benefits with efficient information sharing such as better demand forecasting, Bullwhip effect alleviation, cost reduction, faster decision making, etc. However, there is a deficiency in mechanisms to evaluate whether the information sharing in an organization is efficient or not. As Hugos (2018) mentioned, to understand the opportunities to improve and to identify the weaknesses to mitigate, it should be measured.

There are various performance measurement frameworks to measure the supply chain performance. However, in this information-driven business culture, information flow and information sharing should also be evaluated, thus driving the businesses to improve their information sharing efficiency and obtain a vast variety of benefits.

Reviewed literature expressed about various information quality management frameworks, benefits of information sharing, and methods to improve information sharing in supply chains (Li *et al.*, 2019; Sharma & Kumar, 2017; J. Wang & Zhuo, 2020). However, less evidence was found relating to information flow efficiency evaluation, which will be able to lead organizations to compare information flow efficiencies within and in between organizations.

Many researchers have conducted studies on measuring the supply chain performance aspects using various performance measurement frameworks (Hugos, 2018). However, there was less evidence, where information flow efficiency is accompanied to SC performance measurement. Therefore, the need of conducting a study to evaluate the information flow efficiency was identified.

Since evaluating information flow efficiency as a supply chain performance aspect has been drawn an inconsiderable amount of attention from the researchers, this study will be committed meaningfully to both the business organizations and the academic community.

The identified research problem was to examine the possibility of evaluating the information flow efficiency in supply chains. Due to the time and finance limitations, the study area was narrowed down to the FMCG industry in Sri Lankan context. Thus, the study was carried out with the motive of achieving the below mentioned research objectives.

- 1) To identify the contributing factors that affect the efficiency of the information flow in FMCG supply chains
- 2) To develop metrics to measure the information flow efficiency contributing factors related to the FMCG industry in Sri Lankan context
- 3) To develop an information flow efficiency index to evaluate the information flow efficiency in FMCG supply chains in Sri Lankan context

2. LITERATURE REVIEW

2.1 Supply Chains & Information

The entire system of extracting raw materials, sourcing them to production facilities, manufacturing the products, and delivering them to the final buyers or end users are networked by a supply chain and, examining and managing supply chain networks are simply elaborated as Supply Chain Management. Among the major three flows in a supply chain, information flow is the most crucial flow to achieve an effective and efficient supply chain. Principally, information flow is the flow of data/ information from suppliers to all way

downwards to customers and from customers to, all the way upwards to the suppliers. An information flow of a supply chain contains various info, data, instructions, intelligence, knowledge, reports, advice, messages, tips, etc. This flow is a bi-directional flow that should be streamlined to sustain a performing supply chain network (Nifemi Aluko, 2016).

With globalization, challenging markets, demand uncertainties, and economic competitiveness, constant urge to improve supply chains and end-to-end processes is a requisite to keep the businesses up and running. Therefore, one of the most crucial factors of achieving above mentioned requirements is the up-to-date and accurate decision making of a supply chain (Kolinski & Jaskolska, 2018). Decision making exclusively depends on the information that the decision-maker has received. However, there are some related characteristics that belong to information, providing some act of timely communication for the decision-maker thus adding value and assisting the decision-making process. As an example, the information that the decision-maker has received should be accurate, consequently assisting to make an accurate decision out of the previously received accurate information.

2.2 Fast Moving Consumer Goods Industry

As the name demonstrated itself, FMCG products are fast-moving consumer products that have a short shelf life and can be consumed by all strata of the societies in a country (Kumar Sagar *et al.*, 2018). Furthermore, as Patil (2016), stated that, in the modern world, the FMCG sector is an economic key contributor in a country since it touches every aspect of humans' life from each and every corner.

FMCG market has become one of the most emerging markets among Sri Lankan industries. From small scale businesses to huge multinational companies, FMCG industry has been dispersed across the whole country providing people with diverse product portfolios. Referring to the FMCG market sector report by NDB securities, ("NDBS- NDB Securities," n.d.) products of food, non-alcoholic, alcoholic and tobacco, have contributed to the Gross Domestic Product (GDP) in about 30.0% of the country. This includes wholesaler and retailer trades and further, above mentioned sectors have contributed to around 20.0% of overall employment in Sri Lanka. Furthermore, these contribution percentages are more likely to increase due to the growth of the FMCG market and the increasing spending power of Sri Lankan households.

2.3 Information Flow Efficiency

An efficient information flow is an essential in supply chain performance because, it affects other supply chain and organizational functions directly thus, making the organizational performance decrease. Further, as previously demonstrated, supply chains use performance measurement systems to measure, evaluate and control the supply chain functions efficiently. Therefore, it can be confided that information flow should also be measured, evaluated, and controlled thus, it will not be affecting the other supply chain functions and make the overall performance weak (Kolinski & Jaskolska, 2018).

Evaluating information flow efficiency has got very minor attention from the researcher community. As Kolinski & Jaskolska (2018) mentioned, maybe this was caused by the underdevelopment of information flow efficiency definitions. Further, they have stated that information flow efficiency analysis had only been integrated very lowkey to the organizational evaluations and most predominantly, information flow efficiency measurement has been considered as a difficult practice to apply practically in organizations.

Badenhorst *et al.* (2013) have conducted a study related to the telecommunication cable manufacturing industry in South Africa, identifying the characteristics that can be used as indicators in information flow efficiency. The importance of efficient information sharing and measurement of efficiency were also illustrated in the respective study.

Generally, efficiency has been defined as a timely manner. However, the efficiency of an information flow is not solely dependent on the “timeliness” of information (Badenhorst *et al.*, 2013). There are more contributing factors to the efficiency of an information flow such as “uniqueness” of information, “accuracy” of information, “consistency” of information, “understandable” information, etc. As an example, sharing easily understandable information directly affects the speed of making decisions, thus increasing the information flow efficiency. Especially, these considerations are extensively valid in the FMCG industry due to the tremendous amounts of data/ information that are being shared in FMCG SCs.

Concerning the physical time aspect of information sharing, with the exponential advancements in the technologies of communication and information sharing, data/ information now can be shared in a blink of an eye. Therefore, measuring the physical time aspect of information flows is not quite insightful as of today. Most modern-day organizations use Information Systems (IS), Enterprise Resource Planning systems (ERP), Customer Relationship Management Systems (CRM), Transaction Processing Systems (Daneshvar Kakhki & Gargeya, 2019) to handle and share their data/ information. Therefore, the external information flow efficiency contributing factors should be more focused (e.g., Information accuracy, Relevance of information, etc.), thus providing a more accurate framework.

2.4 Information Flow Efficiency Contributing Factors

The factors that contribute to information flow efficiency were identified through various performance measurement frameworks in supply chains that were not related to information flow efficiency. Further, these factors were identified considering, how the absence of any of these factors affects the SC information flow efficiency. As an example, one of the identified factors is “Accuracy”, likewise, as previously stated, without accurate data/ information, an information flow could not be efficient. Notably, data and information quality directly affect the efficiency of an information flow. Therefore, below stated information flow efficiency contributing factors were identified referring to various data and information quality measurement frameworks and information flow related studies.

- TIQM (Total Information Quality Management) – Completeness, precision, contextual clarity, usability, non-duplication, Consistency, accuracy, rightness
- TDQM (Total Data Quality Management) – Appropriateness, concise/ consistent, objectivity, security, understandability, accessibility, completeness, believability, relevance, timeliness, free of error

In addition to the above-mentioned frameworks, various information quality dimensions of more other researches, various business performance measurements, accounting information characteristics were reviewed and information flow efficiency related contributing factors were extracted to create a list of identified factors (Badenhorst *et al.*, 2013; Foley & Helfert, 2010; Nagle *et al.*, 2020; Pipino *et al.*, 2002; Zahedi Nooghabi & Fathian Dastgerdi, 2016).

Initially, there were 19 contributing factors identified from the literature and, 5 factors were identified by conducting 3 rounds of expert interviews, with professionals having around 5 to 10 years of industry experience in the Sri Lankan FMCG industry.

These factors will be incorporated, to examining the possibility of evaluating the information flow efficiency, using the methods which will be elaborated in the next section. As the Literature implied, even though information sharing benefits and supply chain performance measurements have captured much attention from various scholars, evaluating the information flow efficiency in supply chains has been kept unexplored. Especially, there was hardly any literature found relating to the FMCG industry in Sri Lankan context. Therefore, the study focuses to examine the possibility of evaluating the information flow efficiency in Sri Lankan FMCG industry.

3. METHODOLOGY

3.1 Research Design

The study conducted according to the below presented research design shown by figure 1.

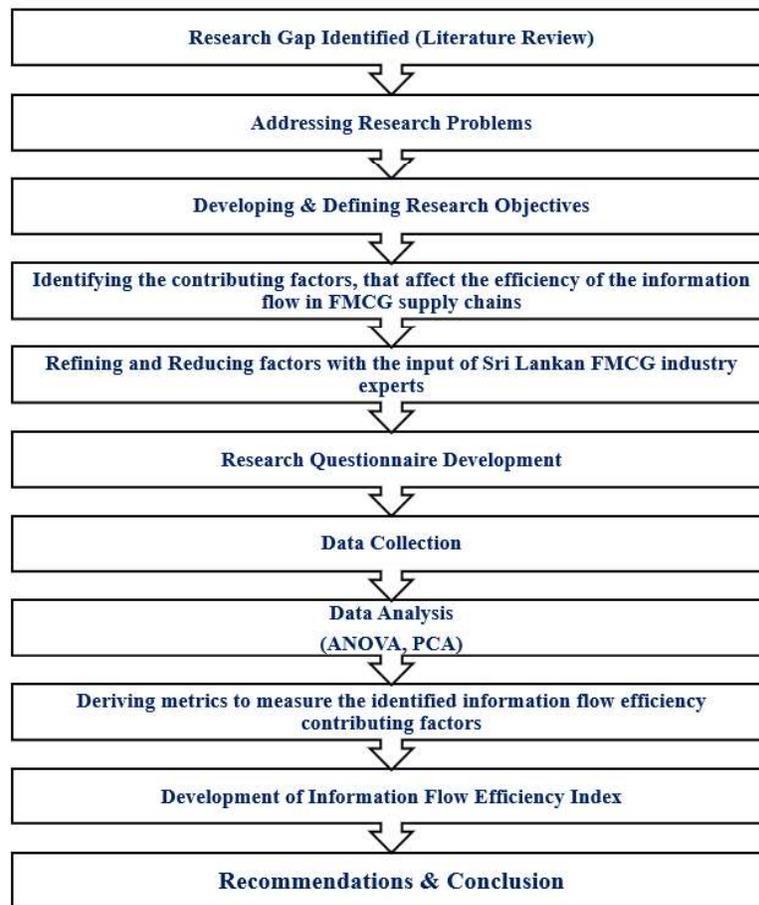


Figure 1. Research Design

As per the research design (Figure 1), after identifying the contributing factors that affect the efficiency of the information flow in FMCG supply chains from the literature and expert interviews, three evaluation rounds were conducted along with the corporation of three FMCG industrial experts in Sri Lanka to refine and reduce the contributing factors to a count

of 9 majorly important factors covering as much as possible aspects. Identified factors are briefly described in below table 1.

Table 1. Identified Information flow efficiency contributing factors

Factor	Short Definition
a. Timeliness	How up to date and timely is the data/ information
b. Accuracy	Correctness of data/ information
c. Relevance	Connection or appropriateness of data/ information to the matter at hand
d. Accessibility	Easiness of obtaining, locating, and receiving data/ information by a user
e. Uniqueness	Each data record should be unique (No duplicated records)
f. Understandability	Easily understandable data/ information by an average user
g. Completeness	Having complete and comprehensive data/ information
h. Consistency	Data/ information synchronization across the organization
i. Security	Protection of data/ information from internal and external threats

If a phenomenon cannot be measured directly, generally, it is linked to directly measurable metrics (Badenhorst *et al.*, 2013; Hugos, 2018). For example, “Relevance of information” could not be either directly measured or observed. However, literature confided that information relevance affects the efficiency of an information flow and the absence of relevant information leads to inefficiency.

Therefore, to measure information relevance, it should be linked to a possible metric. For example, it can be measured by using a scale of receiving the right amount of data/ information in a given situation. Similarly, information uniqueness can be linked to a metric of, “percentage of duplicate records in data/ information a user receives in a given situation”. Therefore, a literature study was performed to determine the possible metrics that could be linked to the information flow efficiency contributing factors. Accordingly, all the identified factors were linked to potential metrics as presented in table 2.

Table 2. Identified factors linked to potential metrics

Timeliness
a) Time it takes to retrieve data/ information after an event occurrence in a given situation
b) Time it takes data/ information to be received by a user in a given situation
c) Time it takes to respond and make decisions after the receipt of data/ information by a user in a given situation
Accuracy
a) Number of corrections required (Average number of errors per given data/ information)
b) Number of review meetings of evaluating stability, reliability, accuracy, genuineness, and trustworthiness of the source/ information sender per given period
c) Existence of data/ information accuracy standards in organization
Relevance
a) Receiving the right amount of data/ information (Not too much or too less data) in a given situation
b) Usefulness of data/ information a user receives for a particular project or a situation
c) Number of review meetings to identify users’ information needs per given period
Accessibility

a) User friendly data/ information access screens
b) Overall easiness of obtaining/ accessing relevant information when needed (Without major obstacles) in a given situation
c) Time it takes to access data/ information in a given situation
Uniqueness
a) Percentage of duplicate records in data/ information a user receives in a given situation
b) Number of multiple versions of same data/ information on various platforms across the organization in a given situation
c) Number of situations where old data have interchanged with newer data in a given situation
Understandability
a) Overall ease of understanding data/ information by an average user in a given situation
b) Availability of help functions to understand data/ information (Formulas, functions, etc.) in a given situation
c) Time it takes to understand given information and make decisions after understanding
Completeness
a) Percentage of missing/ blank records per given data/ information
b) Number of review meetings of sharing complete data/ information across the organization per given period
c) Time it takes to find and fill, incomplete records of given data/ information
Consistency
a) Percentage of records that match/ align across all the databases in the organization in a given situation
b) Percentage of records where all values are in the required format/ layout (Date, text, etc.) in a given situation
c) Number of review meetings to properly format/ organize data/ information layouts (Spreadsheet formatting etc.) per given period
Security
a) Availability of protection protocols to prevent unauthorized access in a given situation
b) Availability of protection protocols to prevent unauthorized data/ information manipulation in a given situation
c) Number of regular backing up of data/ information per given period

3.2 Data Collection

The study collected data using a questionnaire survey and interviews with the Sri Lankan FMCG industry experts. The selected population is the FMCG companies in Sri Lanka and there are numerous FMCG companies currently operating in Sri Lanka. The study selected 07 renowned FMCG companies in Sri Lanka concerning both local and multinational organizations. The study population considered the executives and managers working in information-rich environments in FMCG organizations. Afterward, convenience sampling was used to move ahead with the primary data collection.

Additionally, due to the COVID-19 pandemic caused in 2020, most of the office workers were working from home and Sri Lankan government-imposed quarantine curfew limited the movement of people controlling the spread of COVID-19. Therefore, due to the challenges faced in approaching FMCG organizations, conducting expert interviews, and distributing questionnaires, convenience sampling was the most suitable method to continue.

3.3 Analytical Tools and Frameworks Used

One-way ANOVA was carried out to achieve objective 02 of the study. Analysis of Variance (ANOVA) is a broadly used statistical tool to determine the differences between selected group/ population means (Sawyer, 2009).

Principal Component Analysis (PCA) was carried out to obtain the desired outcome of objective 03.

Principal component analysis (PCA) is a multivariate statistical technique that has been widely used in modern data analysis in various dispersed study fields, was proposed by Karl Pearson and Harold Hotelling (Jolliffe, 2002).

This method is a not complicated, dimension reduction method that has been used for extracting important information from complicated and confusing datasets. Additionally, PCA simplifies a complex dataset allowing the researcher to identify hidden or underlying correlation structures (Shlens, 2014). Furthermore, PCA can transform a large set of correlated variables into a smaller set of uncorrelated variables (Abdi & Williams, 2010), that have been addressed as principal components, and further, those principal components ensure accounting to cover as much as possible variance which was covered with the initial variables (Alegre *et al.*, 2019). As Abeyasekera (1995) stated, principal component analysis can be strictly used for a dataset which has been captured either quantitatively or with ordinal scales.

3.4 Index Construction using PCA

An extracted principal component that was derived by a dataset can be illustrated as a linear combination of all the variables that were subjected to PCA (Tripathi & Singal, 2019). Therefore, it can be indicated as follows (1).

$$\text{Component}_i = a_1X_{1i} + a_2X_{2i} + a_3X_{3i} + \dots\dots\dots + a_nX_{ni} \quad (1)$$

where,

- X_{ni} : subjected variables,
- a_i : principal component coefficients,

Literature evidenced that, studies have used the first principal component extracted to be used in constructing indexes and only the variables with factor loadings higher than 0.5 were retained (Abeyasekera, 1995).

4. DATA ANALYSIS AND RESULTS

Along with the challenges faced due to the COVID-19 pandemic, a total of 70 questionnaire responses were received. Notably, two responses were discarded due to the straight-lining of responses. Questionnaire reliability was ensured by carrying out reliability statistics and, Harman's one-factor test was carried out to test for the common-method bias (Gorrell *et al.*, 2011).

According to the descriptive analysis conducted using the collected data, most of the questionnaire respondents had FMCG industry working experience from 1 year to 10 years. It was ensured that at least having an undergraduate degree would be the minimum requirement to participate in the research thus ensuring the reliability of the responses. Further, almost all the responders were working in information sharing rich functional divisions and all the

respondents were stated the importance of an efficient information flow to the performance of supply chain tasks. Additionally, it was identified that most of the organizations do not officially, necessarily, focus on the information flow efficiency in FMCG organizations in Sri Lankan context.

The study was conducted with a sample size of 68 research samples. Responses were limited due to the COVID – 19 Pandemic limitations & restrictions. Some research studies indicate the minimum sample size to conduct PCA as 10 times the number of variables, and some studies indicated the minimum sample size to be a multiplication of 5 times to the variable count (Hatcher, 1994; Shaukat, Rao, & Khan, 2016). Whereas this study was carried out with 9 variables and therefore, the sample size used for this study can be reasonably justified.

Collected data was used to conduct a PCA to examine the possibility of constructing a composite index to evaluate information flow efficiency. The derived bivariate correlation matrix showed the correlations between variables are an acceptable range and the extracted determinant figure is greater than 0.00001. According to the derived KMO value of the study, the KMO value was in acceptable range and the data analysis was continued. The 1st iteration of PCA disqualified the “security” variable due to being only loaded into the second principal component since a component should have at least three non-cross-loading variables with loading factors in an acceptable range. Variables which disqualify should be excluded and PCA has to be conducted again (Samuels, 2016).

Therefore, data were subjected to PCA for the second time to achieve a more interpretable outcome, and the total variance explained by the extracted components are presented below in table 3.

Table 3. Total variance explained by extracted components

Component	Initial Eigenvalues		
	Total	% Variance	Cumulative %
1	4.257	53.212	53.212
2	0.869	10.857	64.070
3	0.706	8.821	72.891
4	0.556	6.947	79.838
5	0.510	6.381	86.219
6	0.452	5.649	91.868
7	0.357	4.466	96.334
8	0.293	3.666	100.000

Literature stated that the total variance explained by the extracted components should be valued at least 50% (Peterson, 2000; Samuels, 2016). The parallel analysis method was conducted to figure out the number of components that can be extracted. The method has been used to determine the threshold for extracting components and has been consistently proven accurate (Franklin *et al.*, 1995). It was resulted in retaining only the first component from PCA and the component loadings are presented below in table 4. To ensure the reliability of the extracted component, variables were subjected to the Cronbach’s alpha test. Cronbach’s alpha figure needs to be greater than 0.7 to ensure the reliability and the resulted Cronbach’s alpha value was 0.869.

Table 4. Component loadings

1 st Principal Component	Values
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a. Accuracy	0.798
b. Relevance	0.784
c. Timeliness	0.765
d. Accessibility	0.755
e. Completeness	0.724
f. Understandability	0.698
g. Uniqueness	0.688
h. Consistency	0.604

As interpreted in the index construction based on PCA, the extracted principal component can be written as follows using the subjected variables (2) and the component loadings as a composite index (3).

Information Flow Efficiency Index (IFEI),

$$\text{I.F.E.I} = a_1 \text{ Accuracy} + a_2 \text{ Relevance} + a_3 \text{ Timeliness} + a_4 \text{ Accessibility} + a_5 \text{ Completeness} + a_6 \text{ Understandability} + a_7 \text{ Uniqueness} + a_8 \text{ Consistency} \quad (2)$$

After being substituted by the component loadings,

$$\text{I.F.E.I} = 0.798 \text{ Accuracy} + 0.784 \text{ Relevance} + 0.765 \text{ Timeliness} + 0.755 \text{ Accessibility} + 0.724 \text{ Completeness} + 0.698 \text{ Understandability} + 0.688 \text{ Uniqueness} + 0.604 \text{ Consistency} \quad (3)$$

According to all the above-mentioned statistical tests, literature findings, and reliability statistics (Table 3, Table 4, Cronbach's Alpha Value), the derived composite index can be assured as a valid index to evaluate the information flow efficiency in FMCG supply chains in Sri Lankan context.

5. DISCUSSION

Factors identified in objective 01 (table 1) were linked to the literature confided metrics as previously presented in table 2, were included in the questionnaire to obtain the Sri Lankan FMCG industry's expert perception. Afterward, collected data were subjected to an inferential analysis to identify and select the most prominent metrics according to the perception observed from the experts. As Nardo *et al.* (2005) indicated that, factors and sub-factors can be validated to measure an unknown component with the opinion of experts and statistical structures. Accordingly, one-way ANOVA was carried out to identify the most prominent metrics to measure the information flow efficiency contributing factors according to the FMCG industry expert perception. The most prominent metrics were derived considering the mean differences and mean values of the responses given to each metric. One-way ANOVA was conducted using SPSS version 25.0 software package; a statistical software package developed by IBM, and multiple comparisons and Tukey's Test for Post-hoc Analysis were considered. The identified most prominent metrics are mentioned below in table 5.

Table 5. Identified most prominent metrics

Timeliness

a.	Time it takes data/ information to be received by a user in a given situation
	Accuracy
a.	Number of corrections required (Average number of errors per given data/ information)
b.	Existence of data/ information accuracy standards in organization
	Relevance
a.	Receiving the right amount of data/ information (Not too much or too less data) in a given situation
b.	Usefulness of data/ information a user receives for a particular project or a situation
	Accessibility
a.	Time it takes to access data/ information in a given situation
	Uniqueness
a.	Percentage of duplicate records in data/ information a user receives in a given situation
	Understandability
a.	Overall ease of understanding data/ information by an average user in a given situation
b.	Time it takes to understand given information and make decisions after understanding
	Completeness
a.	Percentage of missing/ blank records per given data/ information
	Consistency
a.	Percentage of records where all values are in the required format/ layout (Date, text, etc.) in a given situation
	Security
a.	Availability of protection protocols to prevent unauthorized data/ information manipulation in a given situation
b.	Number of regular backing up of data/ information per given period

Regarding the usage of the information flow efficiency index as an organizational practice, there are few studies that have been conducted exploring the development of indexes and implementation. Fernando *et al.* (2012) have conducted a study to develop an urbanization index in Sri Lanka based on the principal component analysis. To adopt such index, minimum and maximum values of the index should be defined and that can be achieved by developing scales to the metrics that are linked to the factors in the index.

As achieved in objective 02, metrics to measure the information flow efficiency contributing factors were developed. By developing scales to each metric, the minimum and maximum values of the index should be identified. Notably, scales defined by organizations are generally unique to each organization, aligning them to the organizational objectives and requirements.

For example, from the urbanization index creation that has mentioned previously, Fernando *et al.* (2012) had identified, -0.4044 as the minimum value and, 11.6713 as the maximum value of the urbanization index, then calculated the index value focusing on the level of urbanization for Sri Lankan divisional secretariats to detect the leading divisional secretariats.

Therefore, the developed index could be used to evaluate the information flow efficiency between various supply chain divisions, functions, processes, and between organizations. This will encourage the organizations and supply chains to identify information flow improvement opportunities, compare information flow efficiency index scores, identify bottlenecks in the information flow, establish information flow efficiency standards, thus leading them to high-performing efficient supply chains and organizations.

6. CONCLUSION

This study was carried out with the main objective of, evaluating the efficiency of the information flow in supply chains. Due to having a limited time availability and larger research scope, the study area was narrowed down to, evaluating the information flow efficiency in FMCG supply chains in Sri Lankan context. Based on the literature review conducted and the descriptive and inferential analysis carried out, it can be concluded that information flow efficiency in supply chains can be evaluated, and this study has provided an index to bring it to fruition, in FMCG supply chains in Sri Lankan context.

This research addressed the importance of evaluating the information flow efficiency in supply chains and, provided an efficiency index to be practiced. Calculating the index score will provide new insights regarding the information flow efficiency improvements and weaknesses in organizations. As it was mentioned previously, with the ambiguous knowledge organizations have regarding the efficiency of information sharing, this study is making them aware about evaluating it.

Initially, the study was planned to conduct further with developing scales to standardize the extracted index for the Sri Lankan FMCG organizations by conducting a case study. However, due to the COVID-19 Pandemic, most organizations were practicing remotely-working concepts and the standardization of the index could not be achieved. Developing scales for each metric according to an organizations' objectives and requirements can be suggested for future research.

The derived index and the metrics were developed based on solid statistical frameworks thus, accuracy and reliability can be assured. Ultimately, it can be concluded that the information flow efficiency can be evaluated and, the study proposed a solid statistical method to be carried out to do so. Therefore, this research answered the fundamental research questions identified successfully and achieved the research objectives with a significant outcome.

Additionally, the COVID-19 crisis caused industries with labor-intensive production processes to partially shut down or limit the production whereas, information & technology related industries were bloomed and continued to function. Seetharaman (2020) published an opinion paper regarding business model shifts due to the impact of the COVID-19 pandemic and it states that information-intensive industries such as the retail industry need to consider business shifts such as digital replacement of systems, to efficiently share information and survive in the market. Moreover, possibly the world will either be converted back to the previous status or will continue to function as the new normal of remotely working, and remotely working need excessively efficient information flows in supply chains and this study will be committed meaningfully regarding those aspects as well.

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