Use Of Image Recognition Technology in Generating Reports from Kirana Stores in India for FMCG Companies

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Abstract

 Kirana stores in India stock various products of different brands and varieties, and are the first point of purchase for most Indian Households. It is an important channel for all FMCG companies and they endeavor to be present in these stores. It becomes important for FMCG companies to ensure their products are both available and visible in the store to the consumer to be able to buy them with ease. As a practice, it has become important for them to regularly audit and maintain inventory reports in order to ensure the distribution can sell to the retailer and the customers can get access to products preferred by them without any delay. In order to address these concerns, there has been growing interest in the adoption of image recognition technology in the identification and classification of products which currently has been done in large stores. The prior studies, however, have either suggested for or against adoption. The current study suggests the adoption of technology under a machine-based product recognition system is used to collect data regarding the availability of different products. The current study focuses on two distinct brand windows having products of the same FMCG which should be gradually expanded to include products from different brands and such classification would reduce the problem of ineffectiveness of current audit reports

Keywords: Technological innovation, Image Recognition technology, Kirana stores, FMCG sector, Report Generation.

Introduction

General Trade Retail stores for FMCG products or Kirana stores are a major part of total retail stores in India, with it being expected to be above 14 million in number. A major aspect of such stores is they sell products which are of lower price margins and hence needed constantly by the customers. Another aspect is their total sales largely depend upon customer relationships. However, technical analysis suggests such a relationship largely depends upon the level of inventory as well, as there have been significant concerns about both under and over-inventory (Bharti & Shah, 2021). These challenges have been considered to be answered through the adoption of different technological tools as suggested in the study conducted by Wei et al. (2019), as such technology can help in measuring past trends, seasonality of the data, and also sudden expected surges which can lead to better management of inventory and supply chain which will then lead to better management of revenue system of the organisation. The study by Kakar (n.d.) has suggested that

Kirana stores are increasingly adopting newer technologies due to customers becoming less loyal to brands as well as the need to integrate the experience into the shopping of products. Kirana stores play an important role in the entire distribution chain hence it has become important for them to accommodate newer technologies which will aid in the growth of customers. Here, the study conducted by Kakar et al. (n.d) shall also be considered which suggested grocery, personal care, and HFD categories saw significant growth in sales in Post second covid wave. Such data leads to the inference that technology such as image recognition can play a major role in reducing time consumption and allowing focus on the sales process. A primary technology among such tools is being considered to be image recognition technology which is expected to aid in managing stock levels across the store and ensuring inventory is not misappropriated during any point of sales. The current practice however involves a manual audit of the store usually in a fixed time frame like weekly which can be altered with respect to expected demand, but such leads to significant challenges and possibilities for human error as well, which is expected to be addressed by technological tools like an integrated image recognition system. The system however also faces the barrier of higher costs of adoption as well as employee skill challenges which have been considered in this project in order to analyse the impact of usage of image recognition systems in Kirana stores feeling under the FMCG sector in report generation when compared with manual stores.

Literature Review

Technological Integration and Retail stores

Retail stores around the world have started to adopt different digital technologies with the aim of ensuring a better and more sustainable performance of the firm with respect to competitors. The primary aim behind the adoption of the technology has been ensuring convenience to the customers by providing a digital environment which is as similar if not better than the traditional physical environment. Growth has been in the sector of adoption of mobile-based technologies as well, where either singular aspects like billing or entire operations from the selection of products to pay for the product are being done through an integrated system based on the customer's mobile phone (Perry et al., 2021). The adoption rate of new technology in retail stores is dependent upon three major factors as identified in the study conducted by Fan et al., (2022) namely, the level of human-machine interaction desired by the company, availability of technological as well as financial resources with the organisation, and quality of content available with the organisation. These factors are then region as well as customer-segment-specific and hence thus lead to the different levels of customer adoption of such services, notwithstanding the presence of a general framework. Hence, the level of technology acceptance depends upon social variables as well. Another major aspect of technology adoption has been with regards to personalizing the experience available to customers as noted in the study by Riegger et al. (2021) who suggested such bits of help in ensuring each customer has an individual experience which is unique and meets the needs of the customer. However, such technology tools lead to challenges of privacy as well as concerns of cybersecurity as well which can reduce the level of particulate from the customer side. It should be noted personalisation and order customisation is currently major adoptions and are expected to drive technology integration faster. A back-end aspect of technology utilisation has also been considered in the study conducted by Marco (2019) who suggested such technologies can be adopted to handle back operations as well which includes but is not limited to managing operations of the entire store, managing inventory levels, and managing the supply chain operations of the

firm. These operations however not have to be conducted by singular technology rather can be conducted in an integrated environment where such is connected with customer perception as well. The primary reason behind the connection is to ensure real-time customer demand is integrated with inventory and supply chain ensuring a better order fulfilment rate. The integration of different technological tools with Kirana stores has also been supported in the study conducted by Kakar (n.d) who consider it as one of the major attributes which can increase the rate of customer engagement.

Image Recognition technology and attributes

Image recognition technology has been defined by Kosinski (2021) as an innovative technology under which computational programs have been utilised to identify both persons as well as objects and actions conducted by them in a given image at a given timeframe. Image recognition technology has been considered to have significant applications across the world in several industries, from agriculture to retail and from finance to defence, based on its ability to correctly identify singular or multiple objects and attributes from a given image, which can then be used for further analysis and development of new business processes. As noted in the study conducted by Fujiyoshi et al. (2021), image recognition technology largely depends upon the technology available as well as the dataset which has been used to train the software. Hence, it should also be noted that image recognition technology establishment is an expensive and time-consuming affair which requires significant computational reserves as well. Image recognition, by itself, is dependent upon the quality of images as well, as such forms the input in which different actions are undertaken. Here, it should be noted that several biases in selection may occur due to such errors in the system which need to be addressed in a continuous manner. Several scholars like Abdullah (2022) have analysed the applicability of image recognition technology in retail industries around the world, particularly in the FMCG segment. The major challenge has also been a major opportunity which is the wide range of products of different qualities as well as price points which are offered. Such products, on one hand, are a significant opportunity as it remains harder to be analysed by humans manually but the present challenge of preparing comprehensive tool guides which can affect the right allocation of appropriate tags to each product individually. However, the scope of such adoption is growing with the growing need to make the business process more efficient. Such technology currently, as explained in the study conducted by Tarallo et al. (2022) has been adopted in two specific types of products in the FMCG industry, namely products which come under the perishable category and products which have a shorter shelf life when compared with other products. The primary reason behind such adoption has been ensuring retailers have sufficient knowledge regarding inventory level in such products as such will aid them in developing better supply chains as well as marketing programs which will reduce the probability of product wastage due to perishability and expiry of the usage period.

Kirana stores and Performance Metrics

Kirana stores have given significant importance to performance metrics which are associated with the placement of the products as noted in the study conducted by Arora (2022). Here, the aspect of the visual presentation of products is often taken into consideration, though its measurement is complex and often involves several variables like location advantage and customer satisfaction as well which may need to be addressed adequately in objective terms. Despite this, the performance here is measured through the effect

on total sales of the product with respect to the location of the product in the store and the different tools which are used to them promote the product. A case study developed by Kamath et al. (2022) suggests the reasons behind the adoption of such performance metrics, which is the need to maintain stable growth rates in a highly competitive and price-fluctuating market. Here, the rate of price fluctuation can impact market share significantly leaving little room to compete with growing margins. Performance metrics on the other hand, also become highly dependent upon the level of customer satisfaction, as two shops in a similar region may show different sales of similar products. Products from relatively lesser-known brands as well as quantity offered for sale can also impact entire sales. The role of technology is being observed in different performance metrics as well, which has been suggested in the study conducted by Choudhary & Aithal (2022). Technology adoption is primarily considered with two major objectives for each firm namely reduction of costs and maximization of profits associated with the firm. This has primarily become possible due to a decreasing trend in the price of such products either due to higher adoption or government support and a growing trend of adoption of technological tools across kirana stores around the country, to ensure they do not stay behind the competition. Despite different performance metrics, Ray et al. (2021) argue the current Kirana store ecosystem has not been able to operate within an organised ecosystem, hence leaving them exposed to several risks which can affect the financial as well as operational stability of the entire store. These risks can be financial, operational, as well as technological in nature and can be addressed by ensuring sufficient risk management measures are adopted. The need to adopt such a system has led to the development of unique and local performance metrics which are more based upon past trends faced by shop owners than management trends.

Illustration 1 : Example of products displayed in store

Illustration 2 : Example of how a window should display products in the store

Significance of the Study

The current study will address the major critical gap which has been noted in the literature review regarding the lack of studies showing an effective comparative analysis between both human-based product recognition and image-based product recognition systems. Here, it should be noted that there also exists a significant literature gap regarding the applicability of such image recognition systems in kirana stores which do not deal in one specialised product or deal with different products across different varieties and brands which will be covered in the study. The study will also aid kirana store owners as well as managers to make their current stores more efficient and at the same time also aid developers of such image recognition systems to build products which can better cater to the interests of such retailers in the FMCG industry.

Research Objectives

The aim of the study is to analyse the impact of the use of image Recognition technologies in generating reports from different FMCG companies in India selling products through kirana stores. In order to achieve the aim, the following objectives have been developed:

- To investigate the various aspects of Image Recognition technology
- To compare the effectiveness of manual audit and product review through image recognition technology

Research Method

The positivist research paradigm as suggested in the study conducted by Park et al. (2021) has been adopted in the current study, in order to assume a singular reality in which both manual inspections, as well as image recognition technology, work together for an effective comparative analysis. In accordance with the positivist paradigm, a quantitative research design as noted by Bloomberg & Field (2019) has been adopted to analyse numerical values regarding the effectiveness of both systems. A descriptive research design as suggested by Hunter et al. (2019) is further adopted in order to describe further the impact of the usage of image recognition technology in Kirana stores without the need to explore the reasons behind such impact in a comprehensive manner which will lead to deviation from the scope of the study. SPSS software has been adopted in the current study to analyse the data from 767 kirana stores, under which the majority of the stores (300 or 39.1%) are from the western region followed by 182 or 21.1% from the central region and 143 or 18.6% of total respondents from north region. Out of the total of 767 stores which have been taken into consideration, 754 or 99.3% of the stores have been top stores with the other 13 stores or 1.7% of the total stores representing the boutique population.
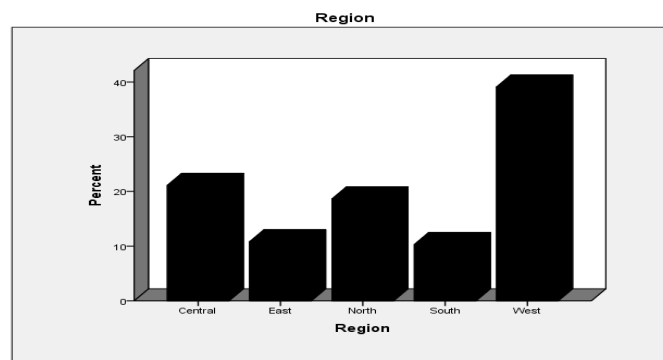

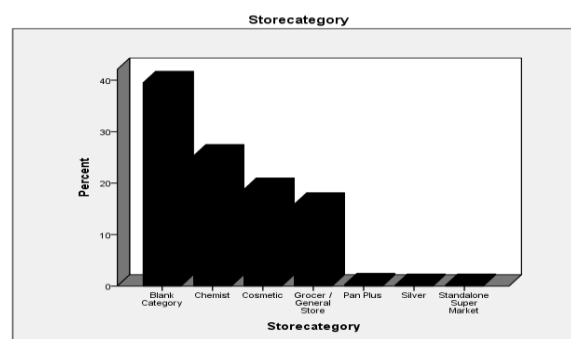**Figure 1: Store division by region**
Source: Author

Figure 2: Store Category
Source: Author

Results and Discussion

The current study has analysed both manual audits as well as audits done through the adoption of an image recognition system, in which under the manual system, the weekly audit was done, and reports were published fortnightly. On the other hand, in the case of the image-based recognition system, audits were done daily and reports were also published daily. Under the manual system, merchandisers visiting the store had to capture images and then answer questions, while under IR (image recognition system), only images were to be clicked. Two brands were taken into consideration. In the case of the first brand , Garnier, Manual scores were higher than IR scores as correlation equals 0.979 with a significance value of 0.000, leading to the assumption that the human-based method may have had glitches due to a different understanding of the product. The same has been suggested for Loreal as well with a correlation of 0.981 and a significance value of 0.000. It should also be noted that the total time consumed inside the store under manual audit in July (39 minutes and 49 seconds) significantly decreased in October (23 minutes and 30 seconds) showcasing better time efficiency in image-based recognition systems.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	ManualGarnierHallaBol Window	1.46	767	1.044	.038
	GarnierHallaBolWindow	1.43	767	1.065	.038

Table 1: Paired Sample Statistics - Garnier

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	ManualGarnierHallaBol Window & GarnierHallaBolWindow	767	.979	.000

Table 2: Paired Sample Correlations - Garnier

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	ManualLorealHallaBolWindow	.96	767	.850	.031
	LorealHallaBolWindow	.95	767	.854	.031

Table 3: Paired Sample Statistics - Loreal

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	ManualLorealHallaBolWindow & LorealHallaBolWindow	767	.994	.000

Table 4: Paired Sample Correlations - Loreal

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	AverageCFTJuly	0:39:49.19	767	0:37:06.372	0:01:20.390
	Avg CFTIROct	0:23:30.42	767	0:18:09.718	0:00:39.347

Table 5: Paired Sample Statistics - Time taken under manual audit and IR audit

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	AverageCFTJuly & Avg CFTIROct	767	.638	.000

Table 6: Paired Sample Correlations - Time taken under manual audit and IR audit

The adoption of such image-based recognition system has already been suggested by Ge et al. (2019) who also suggested a similar notion of errors by humans and time-consuming which is also noted by another study. Another major fact of alignment is the current study focuses on different aspects of product packages while the prior study focused on various aspects of fashion products. The aspect of accuracy which has been considered in the current study has also been covered in the study conducted by Yilmazer & Birant (2021) who also adopted a similar shelf-based methodology, in which image-based recognition systems were used. It should be noted the current study has also focused on the human error perspective, while the prior study has only focused on the higher accuracy level of the image-based recognition system which reduces the scope of establishing reasons which lead to error in the human-based system. Here, it should be noted that the current study compared modern and traditional file audit systems while past systems have focused on the different mechanical systems as well, which included a singular look at shelves and projects which involved both humans and machines together. Hence, both studies have different technical aspects taken into study. The current study, however, is in contrast with the study conducted by Klasson et al., (2021) who suggested that the current image recognition system which shall be used by the retail industry shall focus on not only the classification of images but also provide information behind such content to both retail sellers as well as customers. The current study has negated the view considering such will increase the cost of the products as it would require the development of a system which will collect information

from the internet or website of the company or existing database, and then publish it in a usable format for both resellers as well as customers. Here, it should be noted that the method prescribed in the prior study does not lead to major time deviation but such has not been the primary aspect rather its adoption is the primary aspect of the current study. The current study is also in contrast with the study conducted by Tonioni & Stefano (2019), who suggested the adoption of an image recognition system in the retail chain is harder to even classify products by highlighting three major reasons, namely the presence of more than thousand products which needs to be classified by the imaging system, relatively cheaper and fewer quality cameras used by the stores which can reduce the efficiency of the system, and lack of adequate images published by the company which makes it harder for stores to train their system on. Here, the second and their barrier have been negated by the study suggesting such products are easily recognised on basis of distinct colours which are used in packaging and slight deviations in dimensions but such can be easily identified by the computer system. The first aspect has not been negated however only two brands have been considered for the current study, hence technicalities involved with multiple products are not included in the study. The study has both similar as well as contrasting aspects to the study conducted by Santra & Banerjee (2019). The similarity is in the context that both studies agree adoption of image recognition technology in retail stores will lead to better accuracy as well as a reduction of time consumption which will ultimately lead to a better rate of customer satisfaction ultimately resulting in better revenue and growth rate for the firms. The contrast is the current system, despite being considered to be beneficial for retail organisations, has been considered not applicable for retail institutions, due to the limited finance reserves which such firms have and their potential willingness to invest in this technology. This concept has been negated by the adoption of different models in the study, in which the current study has considered most store owners will focus on improving the rate of efficiency and would agree to spend much money on the system. The current study, in a broader context, aligns with the study conducted by Wei et al. (2020), who considered malls, and suggested the current time lag which is experienced in getting billed for different products purchased can be reduced by the adoption of image recognition systems which hence establishes the concept of efficiency and accuracy. Both studies have focused on different store sizes but the measurement of efficiency (total number of right products verified in comparison with the total number of products verified) and time taken (total time taken either by retailer or by cashier in calculating value of products and total time taken by image recognition system in evaluating the same products). But, the prior study has not suggested human-based error as a major factor behind the selection of digital systems, but such is clearly established in the current study by taking both report generation as well as product audit into consideration. However, a similar study conducted by Wei et al. (2021) stands in direct contrast with the concept undertaken in the current study. It should be noted that such differences exist due to different methodological considerations in both studies. The current study has only focused on the sale of two products in the different forms of Kirana shops under retail outlets, while the prior study focused on a wider variety of products and brands which manufacture various products in different sizes as well as quantities with other aspects like the packaging as well. The current study however adopts the viewpoint of having a uniform database available for training by the company which is negated in the study conducted by Wei et al. (2021). Similar nature of the image recognition system is also recorded in the study conducted by Wudhikarn et al. (2021) who however considered adopting such a system to analyse the barcode of different products and then use it to classify the product into different categories. Here, a barcode has not been adopted due to the fact that two distinct products have been chosen and they can be clearly segregated based

on the dimensions and other aspects like the colour of the product. Thus, it can be inferred that the current study significantly adds to the knowledge in different domains.

Conclusion and Implications

The current study has suggested the adoption of the Image Recognition system in Kirana stores, in order to improve the accuracy rate in retail stores as well as reduce time consumption in such processes which will lead to better performance and thus better revenue for the organisation. Here, manual inspection has not been completely negated rather a hybrid approach has been suggested. The major limitation of the current study is that it has taken into consideration only two brands and has not focused on other aspects of retail stores, like food and beverage products which shall also be studied. Future scholars shall take into consideration more products and also apply them at different times around the year in order to understand the relevance of such systems in different seasons. However, the current study concluded image recognition system has a distinct advantage over the manual recognition system in Kirana stores.

References

[1]   Abdulla, A. (2022). Application of MIS in E-CRM: A Literature Review in FMCG Supply Chain. *Building a Brand Image Through Electronic Customer Relationship Management,* 237-264.

[2]   ARORA, O. (2022). *A Study on Visual Merchandising of Kirana Stores in India* (Doctoral dissertation).

[3]   Bharte, U. L., & Shah, R. D. (2021). Shopping Online and Deliberating Offline: Online Grocery Shopping in Mumbai, India. *International Journal of Education and Management Studies, 11*(4), 213-218.

[4]   Bloomfield, J., & Fisher, M. J. (2019). Quantitative research design. *Journal of the Australasian Rehabilitation Nurses Association, 22*(2), 27-30.

[5]   Choudhary, V., & Aithal, R. K. (2022). Low-cost technologies for Kirana (small) retail: a game changer?. *IIM Kozhikode Society & Management Review,* 22779752221099128.

[6]   Fan, X., Ning, N., & Deng, N. (2020). *The impact of the quality of intelligent experience on smart retail engagement. Marketing Intelligence & Planning.*

[7]   Fujiyoshi, H., Hirakawa, T., & Yamashita, T. (2019). Deep learning-based image recognition for autonomous driving. *IATSS research, 43*(4), 244-252.

[8]   Ge, Y., Zhang, R., Wang, X., Tang, X., & Luo, P. (2019). Deepfashion2: A versatile benchmark for detection, pose estimation, segmentation and re-identification of clothing images. *In Proceedings of the IEEE/CVF conference on computer vision and pattern recognition (*pp. 5337-5345).

[9]   Hunter, D., McCallum, J., & Howes, D. (2019). Defining exploratory-descriptive qualitative (EDQ) research and considering its application to healthcare. *Journal of Nursing and Health Care, 4*(1).

[10]   Kakar, H. -The Impact of Covid-19 Lockdown on General Trade Grocery Stores/Kirana Stores and Independent Self Service Stores in India. 1-20

[11]   Hitesh Kakar, D., Banerji, R., & Singh, M. Sales Impact In Modern Trade Retail During Festival Big Days, Post Wave 2 Of Covid-19, 1239-1246

[12]   Kamath, R., Agrawal, P., & Ahmed, S. (2022). The truant distributor: retain or replace?. *Emerald Emerging Markets Case Studies, 12*(4), 1-31.

[13] Klasson, M., Zhang, C., & Kjellström, H. (2019, January). A hierarchical grocery store image dataset with visual and semantic labels. *In 2019 IEEE winter conference on applications of computer vision (WACV)* (pp. 491-500). IEEE.

[14] Kosinski, M. (2021). Facial recognition technology can expose political orientation from naturalistic facial images. *Scientific reports, 11(*1), 1-7.

[15] Park, Y. S., Konge, L., & Artino, A. R. (2020). The positivism paradigm of research. *Academic Medicine, 95*(5), 690-694.

[16] Perry, P., Kent, A., & Bonetti, F. (2019). The use of mobile technologies in physical stores: The case of fashion retailing. *Exploring omnichannel retailing: common expectations and diverse realities*, 169-195.

[17] Ray, P., Duraipandian, R., & Sinha, R. (2021). An Exploration of the Risk Factors in the Distribution System of the Food Supply Chain in India. *Journal of Computational and Theoretical Nanoscience, 18*(3), 1069-1076.

[18] Riegger, A. S., Klein, J. F., Merfeld, K., & Henkel, S. (2021). Technology-enabled personalization in retail stores: Understanding drivers and barriers. *Journal of Business Research, 123,* 140-155.

[19] Santra, B., & Mukherjee, D. P. (2019). A comprehensive survey on computer vision based approaches for automatic identification of products in retail store. *Image and Vision Computing, 86*, 45-63.

[20] Savastano, M., Bellini, F., D'Ascenzo, F., & De Marco, M. (2019). Technology adoption for the integration of online–offline purchasing: Omnichannel strategies in the retail environment. *International Journal of Retail & Distribution Management.*

[21] Tarallo, E., Akabane, G. K., Shimabukuro, C. I., Mello, J., & Amancio, D. (2019). Machine learning in predicting demand for fast-moving consumer goods: An exploratory research. *IFAC-PapersOnLine, 52(1*3), 737-742.

[22] Tonioni, A., & Di Stefano, L. (2019). Domain invariant hierarchical embedding for grocery products recognition. *Computer Vision and Image Understanding, 182,* 81-92.

[23] Wei, X. S., Cui, Q., Yang, L., Wang, P., & Liu, L. (2019). RPC: A large-scale retail product checkout dataset. *arXiv preprint arXiv:1*901.07249.

[24] Wei, X. S., Song, Y. Z., Mac Aodha, O., Wu, J., Peng, Y., Tang, J., ... & Belongie, S. (2021). Fine-grained image analysis with deep learning: A survey. *IEEE transactions on pattern analysis and machine intelligence, 44(*12), 8927-8948.

[25] Wei, Y., Tran, S., Xu, S., Kang, B., & Springer, M. (2020). Deep learning for retail product recognition: Challenges and techniques. *Computational intelligence and neuroscience*, 2020.

[26] Wudhikarn, R., Charoenkwan, P., & Malang, K. (2022). Deep learning in barcode recognition: A systematic literature review. *IEEE Access, 10, 8*049-8072.

[27] Yilmazer, R., & Birant, D. (2021). Shelf auditing based on image classification using semi-supervised deep learning to increase on-shelf availability in grocery stores. *Sensors, 21*(2), 327.