

## **Determinants of Post- Harvest Losses in Fruits and Vegetables: An Empirical Study of Punjab**

Iradeep Kaur <sup>a</sup>, Prof. Rakesh Kumar Khurana<sup>b</sup>

<sup>a</sup> Assistant Professor in Economics, SCD Government College, Ludhiana  
trehaniradeep@gmail.com

<sup>b</sup> Professor in Economics, Punjabi University, Patiala

### **Abstract**

Post-harvest losses in fruits and vegetables is one of the major problems faced by the cultivators as 15 to 50% loss is faced due to poor handling in storage, transportation, packaging and processing etc. (Roy 1989 and Kiaya, 2014). In this study an effort has been made to examine the causes of post-harvest losses in fruits and vegetables and also the state of various facilities, which can support in reducing the post-harvest losses, available in the state of Punjab. Study is based on the views of the 300 farmers, 50 each collected from the six agro-climatic zones as divided by Punjab Agriculture University, Ludhiana based on the climate and soil texture. To check the association between quantum of post-harvest losses and the factors responsible for it, we have used Chi-square non-parametric test. Though there has been increase in the area under cultivation of fruits and vegetables in the state of Punjab during the last twenty-eight years covered in this study, but the increase in area under-cultivation as well as the increase in quantity produced has been less. Lack of transportation facility, cost of transport, cold storage facility, facility of ripening chambers, processing facility, distance of markets from farms, grading facility, regulation of markets, availability of government facility in the market place is found statistically significantly connected with post-harvest losses. However, we couldn't find any association between mechanical drying facility and post-harvest losses. Though farmers expressed satisfaction with the network of markets available and also were found happy with the regulation system of these markets but they expressed dissatisfaction as the cost of transportation was stated on higher side, there was lack of ripening chambers as well as the processing and grading facilities in the state.

**Keywords:** Post Harvest Losses, Transport Facility, Storage, Processing facility JEL Code: Q13

### **1. Introduction**

India ranks at number two in the world after china so far as the production of fruits and vegetables is concerned (Hegazy, 2016). India's contribution to the total production of fruits and vegetables in the world respectively is 12.40% and 13.30%. Despite being the second largest producer, per capita availability of vegetables and fruits in India respectively is 207g/day and 104g/per day against the world average of 300g/per day and 120g/day (Gajanana, et.al. (2011)). One of the primary reasons for this poor performance is the post-harvest losses across the states in the country. After harvest, fruits and vegetables suffer huge losses between 15% to 50% due to poor handling in storage, transportation, packaging, processing etc. which is one of the major causes of concern (Roy, 1989; Kiaya, 2014). Approximately 40% fruits and vegetables are lost in a year owed to poor storage, handling, packaging, and transportation (Singh et.al., 2014). Committee on Doubling Farmers' Income (2019) has reported that the farmers are unable to sell about 40% of the total fruits and vegetables produced in the market or lose around Rs. 63,000 crore every year for not being able to sell their



produce at all India level (DownToEarth, <https://www.downtoearth.org.in/news/agriculture/every-year-farmers-lose-rs-63-000-crore-for-not-being-able-to-sell-their-produce-59497>).

“Post-harvest fruits and vegetable of value over Rs 2 lakh crore each year get wasted largely as a reason to the lack of food processing units, cold storages and uncaring behaviour in tackling the grave issue of post-harvest losses,” stated ASSOCHAM in a study (Economic Times, 2013, <https://economictimes.indiatimes.com/news/economy/agriculture/indias-post-harvest-losses-over-rs-2-lakh-crore-annually-assochem/articleshow/21652094.cms?from=mdr>).

Of the total produce of fruits and vegetables, in India only 2.2 % is processed, whereas USA and China are much ahead of India in reducing the wastage and adding the additional value to the farm products by processing 65% and 23% of their produce of fruits and vegetables respectively. The post-harvest losses in fruits and vegetables are estimated to be exorbitantly high in India and have increased from 30 to 40 per cent (Hegazy, 2016).

Post-harvest losses have first-order effects on almost 86.2% of the Indian farmers as they being small and marginal farmers (Mint 2018, <https://www.livemint.com/Politics/k90ox8AsPMdyPDuykvl1eWL/Small-and-marginal-farmers-own-just-473-of-crop-area-show.html>). Small farmers in India have another agony too, as they have to sell their produce at low prices soon after the harvest due to lack of storage facility. Therefore, it is important for India to enhance the efficiency and effectiveness in handling, storing, processing of fruits and vegetables so as to reduce the post-harvest losses.

This study investigate the determinants of post-harvest losses in Punjab as the state has played a phenomenal role in bringing green revolution in the country and making the country self-reliant in food grains requirements, but with the passage of time the rotational cultivation of paddy and wheat is not only reducing the income of farmers but is also causing ecological issues like reduced soil fertility and decline in water table. This is a high time that, shift from traditional crop cultivation is made and farmers are encouraged to cultivate horticulture crops which is expected to not only increase the farmers income but will also help in maintaining the ecological balance and though government has put in rigorous efforts in the past to promote horticulture farming but the results have not been that encouraging. Moreover, the soil is mostly sandy loam with pH range 7.5 – 8.5. Therefore, it has good potential for cultivation of various horticultural crops (Horticulture Mission Report, P2018, [https://punjabhorticulture.com/Documents/Events/Horticulture\\_Status\\_Report.pdf](https://punjabhorticulture.com/Documents/Events/Horticulture_Status_Report.pdf)). Out of the various issues which may be acting as hurdle in adopting horticulture farming in the state of Punjab can be the requirement of proper post-harvest handling of horticulture produce which if not taken care can result in produce getting damaged, resulting in huge loss to farmers. Therefore, in this study as attempt has been made to find out the causes of post-harvest loss in fruits and vegetables in the state of Punjab.

## 2. Paper Plan

Section 1 of this paper deals with literature review, Section 2 describes the research methodology, Section 3 deals with trend of area and production of selected fruits and vegetables since liberalization, Section 4 focusses on determinants of post-harvest losses in fruits and vegetables in selected districts of Punjab.

### Section 1

### 3. Review of Literature

**Pantastico (1977)** in a study covering Philippines and Pakistan reported post-harvest losses of 28.1% for fruits and 42.2% for vegetables in Philippines. Pakistan experienced 2 to 18% for reddish and 44 and 52% for tomato and spinach respectively due to lack of transportation, storage, packing and handling inefficiencies. **FAO(1981)** estimated that in developing countries the post-harvest losses vary from fruits to fruits and in case of papaya it is as large as hundred percent. In case of vegetables, losses were estimated between the range of 5 to 100%. Various studies have found the extent and reasons for post-harvest losses in the different states of India. **Mandal et. al (1981)** found out that post-harvest losses in Brinjal were 14% and in Ocra were estimated to be 25% respectively in the Calcutta market. It was noted that these losses were incurred only account of poor facilities of handling, transportation and discoloration etc. **Maini (1983)** reported that post-harvest losses are more in Bhadrugarh Onion than Gujrat Onion because of the traditional storage system which results in spoilage ranging from 25 to 40% of the total production. **Subramanyum(1986)** estimated post-harvest losses in potato as 25 to 40% due to cuts on the bulbs during harvesting, rotting, handling and transport, shriveling and structuring during storage. **Madan et. al. (1993)** found that the post-harvest losses of tomatoes in Delhi were estimated to be in the range of 7.2 to 34.7%, in Maharashtra 15-20% and in UP 4 to 10%. Push cart vendors suffered higher losses as compared to shop vendors. **(George and Mwangangi, 1994)** highest postharvest losses of bananas in terms of increased physical damage incidence and severity occurred due to long transport distance on ill maintained roads. **Rana et.al. (2005)** in their study estimated the quantitative PHL(Post Harvest Losses)



for Kinnow fruits in Punjab, Himachal and Haryana at three different stages, firstly, at orchid level, secondly at commission agent and thirdly at retailer level. The study has estimated that the combined physical losses for these three stages were 28.5% for Punjab, 30.4% for Haryana and 15.7% in Himachal Pradesh. It was found that the main causes in Punjab and Haryana for the Post Harvest Losses (PHL) were due to rotting, transport injuries during crushing-pressing and packing and during plucking. Singh et al., (2009) Losses during the transportation stage and storage are one of the current problems in Indian fresh produce supply chain. **Kishor et al (2006)** in their study stated a loss of 10.42 per cent in onion of which 6.21 per cent, 1.85 per cent and 2.36 per cent losses respectively happened at the field level, at the wholesaler and at the retailer level. In case of potato, of the total loss of 12.97 per cent, 7.34 per cent, 2.22 per cent and 3.41 per cent losses respectively occurred at the farm level, wholesaler and retailer level. **Mitrannavar and Yelledalli(2014)** in a study conducted in Karnataka reported overall loss at different stages of around 177.71 kg (22.86 %) in potato. The maximum loss was reported at the commission agent including wholesaler level. Overall loss including loss at all the stages was reported to be 27.44 %, 21.61% and 22.36% in tomato, brinjal and beans respectively. Retail level reported maximum losses for tomato and brinjal, in respect of beans maximum loss was found to occur at the commission agent-cum-wholesaler level. **Bantayehu, et. al., (2018)** experience and educational levels of producers in fruit production and shortage of labour were the determinant factors of fruit losses during harvesting.

Review of literature points out towards post-harvest losses which ranges from 5% to almost 45% depending upon the type of fruit and varies from state to state and region to region. The main causes reported for huge quantum of post-harvest losses are the poor transportation facilities, ill maintained roads, lack of storage facilities, mishandling during packaging etc. Though a large number of studies on assessment of post-harvest losses have been found a comprehensive study representing the state of Punjab couldn't be found, hence in this study we have analysed the status of post-harvest losses in fruits and vegetables in Punjab State.

### Section 2

#### 4. Research Methodology

To assess the situation of post-harvest losses in fruits and vegetables in Punjab, we have selected six districts as the sample size based on regional classification of Punjab made by Punjab Agriculture University, Ludhiana on the basis of soil textures and climatic features. Punjab Agriculture University, Ludhiana has divided Punjab based on soil texture and climatic features in six regions i.e. Sub Mountainous undulating region, Undulating plain region, Central plain region, Western plain region, Southern plain region and Flood Plain/Bet Area ( <https://dolr.gov.in/sites/default/files/SPSP-Punjab.pdf> ). For the purpose of primary survey, we have taken one district from each region, therefore in total six districts of Punjab i.e. Hoshiarpur, Mohali, Ludhiana, Ferozepur, Moga and Patiala one from each of the stated regions according to the agro-climatic zones are covered.

The districts covered in this study are scattered in the state and belong to different regions. The sample of 300 farmers from six districts (50 from each district) was selected on the basis of stratified random sampling method. Empirical data was collected from the farmers with the help of structured questionnaire and through personal interviews. As during pre-testing of the questionnaire, it was observed that the respondent farmers were not quoting a specific percentage as post-harvest losses rather they were giving estimates like 2 -3%, 3 to 5%, therefore the responses from the farmers were taken in the form of range which was later converted to one specific figure by taking the average of the range. Analysis of post-harvest losses in fruits and vegetables has been made with respect to the major selected categories of fruits and vegetables for the six selected districts of Punjab. Determinants responsible for the post-harvest losses were identified on the basis of previous research studies (Halder and Patti(2011), Bhardwaj and Palaparthi(2008), (Jain (2007), Mathi (2007), Sharma and Singh(2011), Sharma and Singh(2011), Singh et al.(2009), Narula(2011)) and the qualitative responses from the farmers and agriculture scientists obtained through interviews. The determinants of post-harvest losses considered for the purpose of this study include transport facility, cost of transportation, standardization of weights, cold storage, ripening chambers, mechanical drying facility, grading facility, distance of market, market regulation, government facilities.

**Following Hypotheses were formulated to examine the association between Post Harvest Losses and the Determinants considered responsible for such losses:**

- H1:** There is no significant association between transport facility and the post-harvest losses
- H2:** There is no significant association between cost of transport and the post-harvest losses
- H3:** There is no significant association between standardization of weights and the post-harvest losses
- H4:** There is no significant association between facility of cold storage and the post-harvest losses

- H5:** There is no significant association between facility of ripening chambers and the post-harvest losses
- H6:** There is no significant association between processing facility and the post-harvest losses
- H7:** There is no significant association between mechanical drying facility and the post-harvest losses
- H8:** There is no significant association between availability of grading facility and the post-harvest losses
- H9:** There is no significant association between distance of market and the post-harvest losses
- H10:** There is no significant association between regulated market and the post-harvest losses
- H11:** There is no significant association between availability of government facility and the post-harvest losses

Association between selected determinants and the magnitude of post-harvest losses is examined using non-parametric chi-square statistical test for independence:

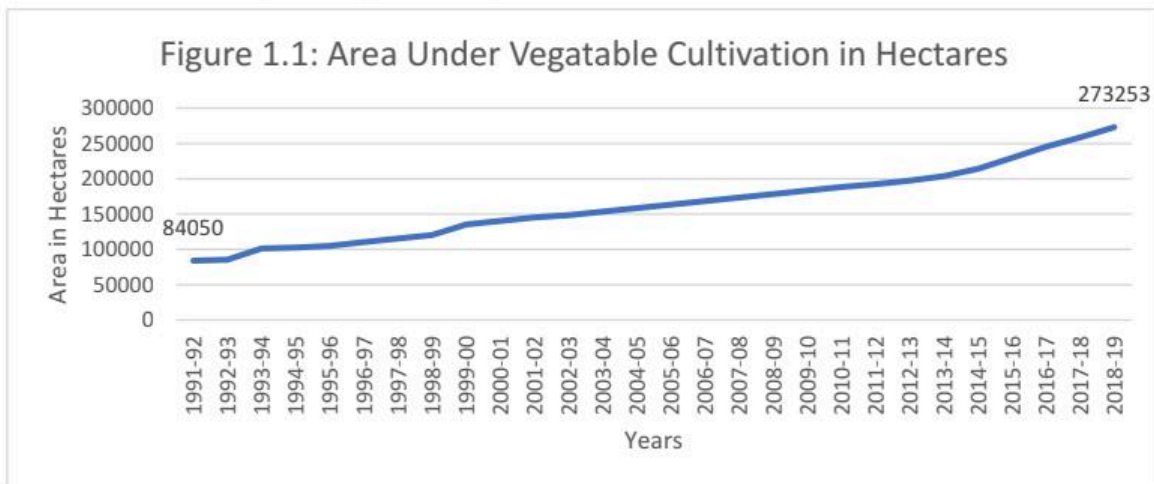
$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

**Section 3**

**5. Data Analysis and Results**

**Trend of area under Vegetables Cultivation Since 1991**

In this section of the paper, an analysis of the trend of area put under vegetables cultivation is examined, the period covered ranges from 1991 to 2018. Figure 1.1 and Table 4.1 below respectively shows the area under vegetables cultivation in Punjab and compound annual growth rate with which area under and vegetables cultivation increased in Punjab during the stated period.



Source: Directorate of Horticulture, Government of Punjab

**Table 4.1:** Compound Growth Rate of Area Under Vegetables

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Case Sequence	1.040	.001	2.691	900.861	.000
(Constant)	87936.289	1620.210		54.275	.000

The dependent variable is ln (VA).

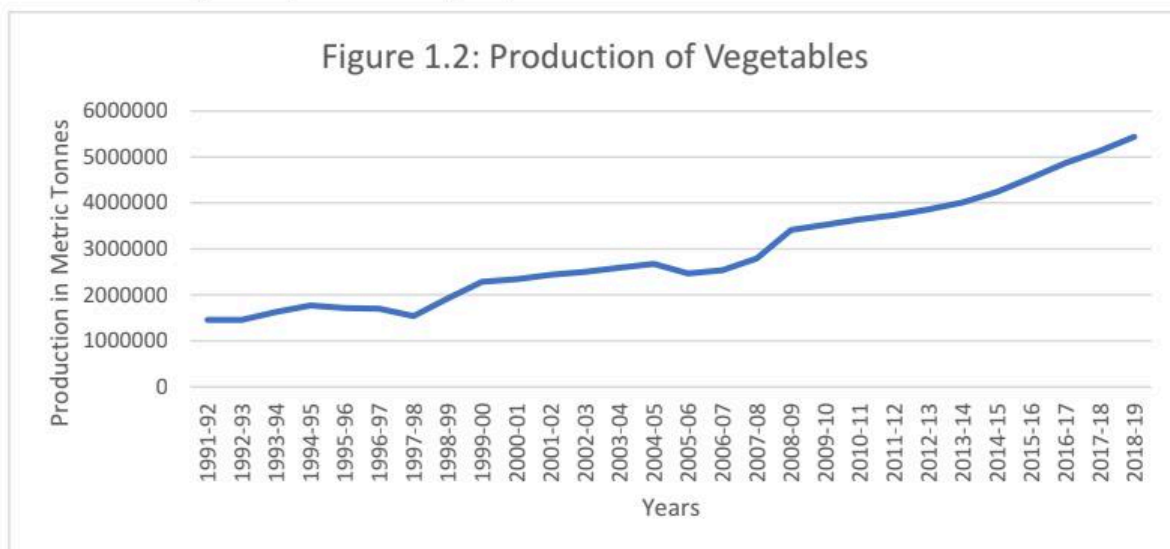
The area under vegetables has been increasing over time, as indicated in the graph. During the year 1991-92, it was 84.05 thousand hectares and had shown an increasing trend till 2018 and it is clearly reflecting from the



graph that an area of 273.25 thousand hectares is under vegetables cultivation. The table 4.1 shows that the area under vegetable cultivation has grown at a compound growth rate of 4% during the period of 28 years since 1991 and found significant at 1%. The remarkable increase has been witnessed and 32% increase in area is attributed in the last 28 years, the results are further shown through graph 1.1. It was a step towards diversification as initiated by the government under National Horticulture Mission (NHM) to boost horticulture crops. Johal Committee (1986) published its report to suggest diversification as shifting from paddy cultivation to vegetables is a major step towards Punjab growth in agriculture and to save Punjab from acute water shortage problems in coming years.

**Trend of Vegetables Production Since 1991**

Figure 1.2 and Table 4.2 below shows the growth trend and compound annual growth rate of the quantity in metric tons of the vegetables produced during the period 1991-92 to 2017-18.



Source: Directorate of Horticulture, Government of Punjab

**Table 4.2: Compound Growth Rate of Vegetable Production 1991-2018**

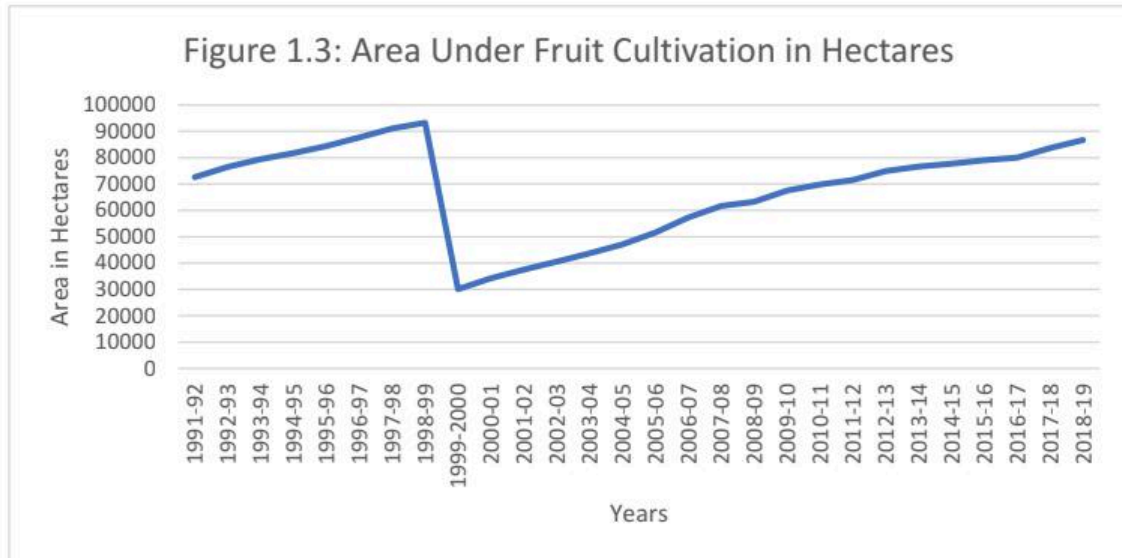
	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Case Sequence	1.050	.002	2.679	608.933	.000
(Constant)	1.339E6	36505.942		36.687	.000

The dependent variable is (VP).

The production of vegetables too has witnessed remarkable increase as can be seen from the graph 1.2. Over a period of 28 years the compound growth rate of 5% is witnessed in the production of vegetables and is also found significant @1%. The production has increased from 145.30 metric tons to 544.22 thousand metric tons, which shows a phenomenal increase. The APMC act in 2002 led towards boosting of marketing of these crops which shows the increase in vegetable production in an overall scenario.

**Trend of Area Under Cultivation of Fruits Since 1991**

Figure 1.3 and Table 4.3 below respectively shows the trend and compound rate of growth of area put under of fruits in the state of Punjab since 1991.



Source: Directorate of Horticulture, Government of Punjab

**Table 4.3: Compound Growth Rate of Area Under Fruit Cultivation**

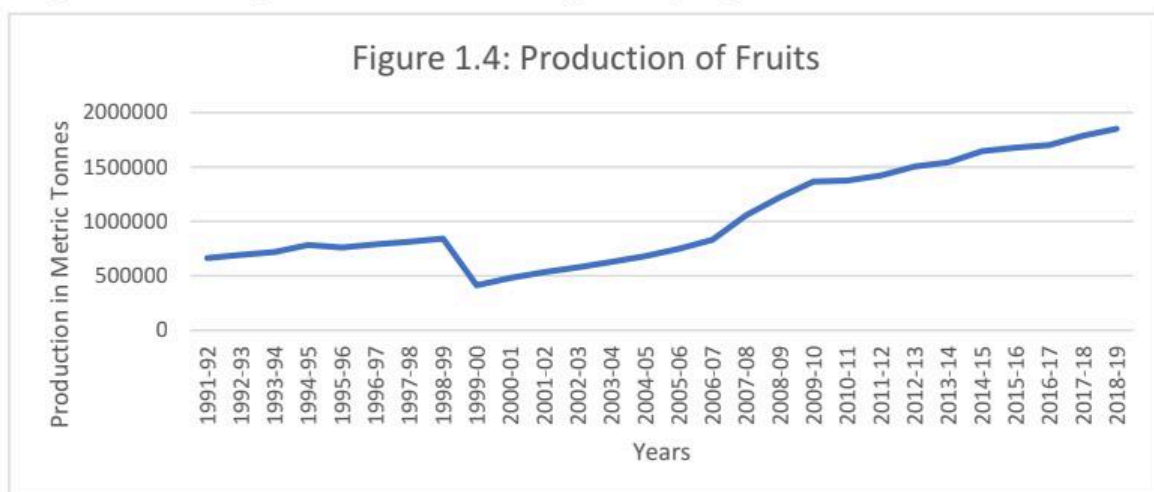
	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Case Sequence	1.005	.008	1.139	133.248	.000
(Constant)	60460.190	7531.317		8.028	.000

Significant @1% level

The graphic analysis in the graph 1.3 and the tabular analysis shown in table 4.3 shows that though there is overall increase in area under fruit cultivation from 1991(72.665 hectares to 86.673 hectares) till 2018, but the CGR worked out has shown a 0.5% increase in area under fruits cultivation, which means that though there is increase but this increase is painfully slow. According to NHM, there is need to boost the area under fruits cultivation to meet the diversification requirements. The fruit crops are grown in 4% of the total area under agriculture in the country (TOI, Jan.16, 2019). This clearly suggest that there is need to increase the area under fruits in Punjab to explore the potential as in Punjab, the total area under fruits is 86.67 hectares.

**Trend of Production of Fruits in Punjab Since 1991**

Figure 1.4 and Table 4.4 below respectively shows the trend of growth in production of fruits and compound annual growth rate of fruit production in the state of Punjab during the period from 1991 to 2018.



Source: Directorate of Horticulture, Government of Punjab

**Table 4.4:** Compound Annual Growth Rate of Fruit Production from 1990-2019

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Case Sequence	1.045	.006	2.269	164.893	.000
(Constant)	498309.537	50159.957		9.934	.000

The dependent variable is ln (FP).

The table 4.4 and the graph 1.4 show that there is increase in fruit production but it has many curvy features, the path does not show continuous increase rather witnessed high variability in fruit production over the last 28 years. The overall increase has been found to be significant at 1% with a compound growth rate of 4.5%. In India, fruit crop now occupies 6.4 million hectares yielding 94.9 million metric tons of fruits annually (TOI, Jan.16, 2019).

**District-wise Area and Production of Fruits and Vegetables**

Table 4.5 below shows the district wise compound growth rate of fruits and vegetables produced between 1991-92 and 2017-18. It can be seen from the table that for the crop of Kinnow highest growth rate of 0.13 was found in Hoshiarpur and lowest rate of CAGR was found in Ferozepur district, w.r.t. CAGR of Sweet Orange district Hoshiarpur experienced highest growth in Punjab, whereas Moga and Ferozepur had CAGR of -1.

**Table 4.5:** District-wise Compound Growth Rate of Area under Fruits and Vegetables

	Ferozepur	Hoshiarpur	Ludhiana	Moga	Mohali	Patiala
KINNO	0.00668933	0.134751	0.11954	0.11697	0.05750	0.046011
SWEET ORANGE	-1	0.101737	0.10784	-1	0.07188	-0.00309
LEMON	0	-0.04476	0.02918	-0.06562	0.02336	-0.00853
MANGO	-1	0.195563	0.05233	#DIV/0!	0.04030	0.020402
LITCHI	0	0.101424	-0.04018	#DIV/0!	0.04901	-0.02981
GUAVA	0.009625748	0.103982	0.07504	0.03915	0.04674	0.07067
PEAR	0.189207115	0.051875	0.06186	0.00986	0.03205	0.023159
PEACH	0.189207115	0.173249	0.048646	0.012929	0.034361	0.088167
PLUM	0.18920711	0.289847	0.02011	0.01763	0.01175	0.055881
GRAPES		-1	-0.00411	-1	-1	-0.10065
BER	0.01504187	-0.03987	0.06176	-0.05538	-0.02091	0.007328
OTHERS	-1	#DIV/0!	0.04577	0.06462	0.02168	0.042497
TOTAL	0.003197994	-0.02687	#DIV/0!	0.03980	0.04286	0.046356
POTATO	0.25645754	0.071568	0.05049	-0.11982	0.021181	-0.00304
ONION	0.7063837	0.111891	0.13099	0.25814	-0.04675	0.0044
GARLIC	0.04949179	0.119037	0.11767	0.28674	0.030647	0.064687
TOMATO	0.582574273	0.170419	0.03734	0.43134	0.03896	0.147404
BRINJAL	0.695635914	0.104054	0.10146	0.40019	-0.0337	0.189524
CAWLIFLOWER	0.29304342	0.036674	0.10690	0.10466	0.116971	0.059833
CABBAGE	0.191266356	0.096464	0.122318	0.243947	0.042081	0.158745
OKRA	0.156595049	0.06966	0.122595	0.482898	0.095301	0.069192
CHILLIES	0.233886757	0.077943	0.093223	0.293353	0.002439	0.01909
PEAS	0.381670296	0.134429	0.103578	0.422408	0.097486	0.054838
MUSK MELON	0.060004836	0.1702	0.055284	0.476643	0.048888	0.049257
WATER MELON	0.084038423	-0.03314	0.051515	-1	-0.01441	0.041651
VINE-VEG	0.203852706	0.001835	0.059424	0.164328	0.029678	0.023008
ROOT-VEG	0.256174106	-0.03907	0.07722	0.379605	0.023916	-0.00319
OTHERS	0.356502546	#DIV/0!	0.128145	0.420343	0.048965	0.111537
TOTAL	0.239656792	0.025459		0.042924	0.016435	0.020805

**Table 4.6: Proportion of Vegetables Production in Total Production of Vegetables**

Districts	POTA TO	ONION	GARLIC	TOMATO	BRINJAL	CAULIFLOWER	CABBAGE	OKRA	CHILLIES	PEAS	MUSKMELON	VINE-VEG	ROOT-VEG	OTHERS
Ferozepur	25.40	3.20	8.90	6.70	8.23	3.52	2.03	1.12	2.48	4.63	1.38	7.36	23.44	0.80
Hoshiarpur	68.88	3.83	2.04	4.01	3.79	3.28	3.33	1.84	0.33	1.70	3.12	2.75	4.22	0.49
Ludhiana	50.09	18.74	1.71	2.40	2.18	4.01	2.46	1.35	0.17	1.98	0.90	2.66	10.81	0.19
Moga	11.81	10.02	9.93	9.91	9.52	7.77	8.18	4.50	0.84	4.49	7.41	5.80	8.49	1.31
Mohali	29.53	13.95	1.33	6.56	2.11	16.31	4.32	1.55	0.40	1.64	3.31	9.24	8.90	0.36
Patiala	34.79	14.62	1.65	10.38	4.34	6.51	5.10	1.34	0.50	6.84	2.48	4.03	6.80	0.29

Six districts were selected according to six geographical zones classified by Agronomy department, Panjab Agriculture University, Ludhiana. From the six zones, major districts such as Ferozepur, Hoshiarpur, Mohali, Ludhiana, Moga and Patiala were selected. According to the table 4.6 the principal crop of vegetable in Ferozepur district is Potato and Root veg crops, which contributes almost 50% to the total production of vegetables in Ferozepur. In the Hoshiarpur district, Potato crop is found to be most significant, as it has the highest percentage of 68.88 contribution in the total vegetables produced in the district. In the district Ludhiana, the percentage of Potato crop production to the total production of vegetables is 50.09, whereas onion contributes 18.74% in the total production among vegetables. In the Moga district, though all the major vegetable crops contribute in the same percentage, but Potato and Onion together contribute more than 20%. In the Mohali district, the main vegetable crop grown is Potato, which contribute 30% in the total production of vegetables of the district and other significant crops are cauliflower contributing 16.31% and onion contributing 13.9% in the total vegetable production of the district. In Patiala district the Potato crop contributes to around 35% in total production pool and onion contributes around 14.6% in total production.

**Table 4.7: Proportion of Fruits Production in Total Production of Fruits**

	Kinnow	Sweet Orange	Lemon	Mango	Litchi	Guava	Pear	Peach	Plum	Grapes	Ber	Amla	Banana	Others
Ferozepur	20.84	0.00	0.00	0.00	0.00	67.64	1.64	1.22	1.21	0.00	6.09	0.00	0.00	0.00
Hoshiarpur	71.91	0.89	0.63	13.39	3.78	2.91	1.05	1.56	0.53	0.00	0.05	2.32	0.03	0.95
Ludhiana	15.20	0.52	1.86	8.77	0.14	40.89	8.85	4.78	0.39	1.41	6.13	0.32	6.07	4.68
Moga	44.57	0.00	0.33	0.00	0.00	50.72	0.47	0.74	0.39	0.00	0.56	0.00	0.00	2.23
Mohali	15.53	0.31	1.22	24.98	3.08	38.91	2.97	2.80	0.22	0.00	0.88	1.02	0.24	7.85
Patiala	3.81	0.39	1.35	12.61	0.30	49.60	6.20	6.76	0.66	0.11	4.60	0.14	0.00	13.46

#### District-wise Production of Fruits

Table 4.7 above shows the contribution of each fruit in percentage terms in the total quantity of production of fruits of the district. It is evident from the above table that Guava contributes around 67.64% in Ferozepur district and Kienow is the second most significant crop with a contribution of 20.84%. The Kinnow has the highest contribution in the district Hoshiarpur with 71.71% contribution in the total production of fruits in the district and the second most grown crop in Hoshiarpur is mango with 13.39% contribution to the total production of fruits. In the Ludhiana district, table 4.7 shows that Guava is the main fruit produced with a contribution of 40.89% and Kinnow stands at number 2 with a contribution of 15% in the total production of fruits in the district. Moga district is concentrating on the production of only two fruits i.e. Guava with a production share of 50.72 and Kinnow with a share of 44.57% in the total production of fruits. District Mohali produces mainly Kinnow with a production share of 15%, and Guava with a production of 38.91%. In the Patiala district Guava is the main crop with 49.60% contribution to the total pool of fruits and Mango is the second largest contributor in the district with 12.61%.

#### Section 4

#### 6. Determinants of Post-Harvest Losses

The report published in the economic times dated January 16, 2019 stated that the country is incurring post-harvest losses worth Rs. 2 lakh crores per annum due to lack of storage and processing facilities. As reported in the study, India is the second largest producer of the fruits and vegetables in the world and due to non-availability of appropriate cold storage, refrigerated transportation facility, the fruits and vegetables worth crores get spoiled every year (Bhosale, 2013). The major factors which contribute to the post-harvest losses of the



## Determinants of Post- Harvest Losses in Fruits and Vegetables: An Empirical Study of Punjab

different fruits and vegetables are the harvesting methods, handling, transportation facility, preservation techniques, market availability, storage and lack of pre-cooling facilities (Singh, et. al. (2014)). The results of chi-square regarding determinants of post-harvest losses in fruits and vegetables in the selected six districts of Punjab are given in table 4.8 below:

**Table 4.8:** Factors Affecting the Post-Harvest Losses in the state of Punjab

	Very bad		Bad		Satisfactory		Good		Very Good		Weighted Avg. Score
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	
Transportation	184	61.3%	12	4.0%	6	2.0%	2	.7%	88	29.3%	674
Cost of transportation	252	84.0%	48	16.0%	0	.0%	0	.0%	0	.0%	348
Standardised weights	230	76.7%	66	22.0%	2	.7%	0	.0%	2	.7%	378
Cold Storage	209	69.7%	70	23.3%	2	.7%	16	5.3%	3	1.0%	434
Ripening chambers	251	83.7%	49	16.3%	0	.0%	0	.0%	0	.0%	349
Processing Facilities	249	83.0%	37	12.3%	2	.7%	4	1.3%	0	.0%	345
Facility for Mech. Drying	260	86.7%	36	12.0%	4	1.3%	0	.0%	0	.0%	344
Grading Facility	191	63.7%	101	33.7%	5	1.7%	3	1.0%	0	.0%	420
Markets Nearby	24	8.0%	1	.3%	11	3.7%	136	45.3%	128	42.7%	1243
Regulated Markets	0	.0%	4	1.3%	4	1.3%	60	20.0%	230	76.7%	1410
Government facilities for Marketing	106	35.3%	99	33.0%	25	8.3%	20	6.7%	48	16.0%	699

To calculate weighted average score, Very Bad is multiplied by 1, Bad by 2, Satisfactory by 3, Good by 4 and Very Good by 5. Weighted Average Score indicates the relative positioning of each factor chosen in the state of Punjab. Higher score indicates that particular factor is in a relatively better condition as compared to other factors. Table 4.8 above shows the status of the factors which can help in reducing the post-harvest losses in the fruits and vegetables. It can be seen that so far, the availability of the markets at near distance from farms and regulation of such markets in Punjab is concerned, the state of affairs is much better as compared to other factors as indicated by the highest scores of 1410 and 1243 respectively, but the state of facilities with respect to mechanical drying, cost of transportation, processing facilities, ripening chamber etc is not in a very good state of affairs. Further cost of transportation is also felt to be on a higher side by the respondents as indicated by a very low score of 348. Further, there is a need to scale up the grading facility in the state.

**Table 4.9:** Association Between Factors and Post-Harvest Losses

Sr. No.	Factors	Person's Chi Square Value	p value	Phi Value
1	Transport Facility	91.695	0.000	.553
2	Cost of Transportation	34.544	0.000	.339
3	Standardized Weights	1.20	0.000	.634
4	Cold Storage	1.051	0.000	.592
5	Ripening Chamber	61.396	0.000	.452
6	Processing Facility	53.578	0.030	.423
7	Mechanical Drying	21.845	0.239	.239
8	Grading Facility	1.311	0.000	.661
9	Distance of Market	1.998	0.000	.816
10	Regulated Market	3.6652	0.000	1.103
11	Government Facilities in Marketing	2.019	0.000	.820

As can be seen from table no. 4.9 all the above null hypotheses stand rejected at 1% level of significance, except the hypotheses H7 i.e. statistically significant association is found between the availability of transportation facility, cost of transport, availability of cold storage facility, facility of ripening chambers, processing facility, distance of markets from farms, grading facility, regulation of markets, availability of

government facility in the market place. However, null hypothesis H7 is accepted as statistically association between availability of Mechanical Drying Facility and Post-Harvest losses is found to be insignificant.

## 7. Conclusion

It is found that the area under vegetable cultivation has grown at a compound annual growth rate of 4% during the period of 28 years since 1991 whereas quantity produced has gone up by 5%. Increase in area under fruit cultivation from 1991 till 2018 has painfully been very less at 0.5%, but there has been seen a good increase in quantity produced at 4.5%. Among the vegetables grown in the state of Punjab, potato is most grown vegetable and similarly among the fruits, Guava and Kinnow are the main crops in the selected districts of Punjab.

It is found that the factors contributing to post harvest losses include availability of transportation facility, cost of transport, availability of cold storage facility, facility of ripening chambers, processing facility, distance of markets from farms, grading facility, regulation of markets, availability of government facility in the market place. However, we couldn't find any association between mechanical drying facility and post-harvest losses.

Study also found that availability of the markets at near distance from farms and regulation of such markets in Punjab is concerned, the state of affairs is much better as indicated by the highest scores of 1410 and 1243 respectively, but the state of facilities with respect to mechanical drying, cost of transportation, processing facilities, ripening chamber etc is not in a very good shape in the state. Further cost of transportation is also felt to be on a higher side by the respondents. Further, there is a need to scale up the grading facility in the state. In the light of above, state is advised to put efforts in the direction of providing low-cost transportation facility, ramp up processing and grading facility for fruits and vegetables and also provide ripening chambers in the markets of Punjab to help in reducing the post-harvest losses.

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## USERS' DEMOGRAPHICS AND ADOPTION OF ELECTRONIC PAYMENT SYSTEMS WITH SPECIAL REFERENCE TO NORTH INDIA

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Prof. Ravi Inder Singh\*  
Ms. Iradeep Kaur\*\*

### ABSTRACT

*Electronic Payment Systems(EPS) have brought revolutionary changes in the payment Industry at Global Level. Indian Banking and Payment industry has also seen huge structural changes due to the emergence of EPS. With easy availability of Internet access in far flung areas of the country at very low cost and deep penetration and use of smartphones, EPS use has increased rapidly in India in the recent past. It is further noted that though EPS adoption as means of payment settlement is increasing but it is not stable. A large chunk of population has not used EPS even once till now, majority of those who are using EPS they are not consistent and have number of doubts with respect to the reliability etc. of the EPS system. Therefore, in this study(conducted as a part of ICSSR, New Delhi sponsored project) an effort is made to examine the status of use of EPS in India. An effort is made to also analyse the association between demographic characteristics of users with the adoption of EPS. The status of adoption of EPS is analysed on the basis of secondary data taken from CLSA 2020 Report. To examine the association between demographic variables and adoption of EPS primary data is used. The primary data represents the views of 759 respondents from three important states i.e. Punjab, Haryana and Himachal representing different segments of society in terms of age, occupation, qualification, rural and urban area and income. It is found that India is the leading user of EPS in the world with transactions worth US\$ 25.5 billion settled through this system in India in 2020, people most use digital wallets and UPI here and Phonepe and Google Pay are among the most popular digital wallets in the country. With the help of Chi-Square applied on primary data it is found that demographic characteristics such as age, income, qualification, occupation and area of residence are associated with the adoption of EPS. This paper is a part of the ICSSR, New Delhi sponsored project on Electronic Payment System.*

**KEYWORDS:** *Electronic Payment System, Digital Wallets, UPI.*

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### Introduction

Emergence of Electronic Payments System(EPS) have changed the entire face of National and International Payments Systems. Though EPS were available as a means of payment settlement since quite a long time but their use increased rapidly after COVID 19 at the global level and after demonetisation of currency in 2014 in India. EPS with a variety of options like online banking, debit cards, credit cards, ATMs, and digital wallets are spreading very fast across the world. Global Digital Payments Market is expected to increase at CAGR of 11.21 percent from USD 5.44 trillion in 2020 to USD 11.29 trillion by 2026(Businesswire, 4 June, 2021). Global Payment Report (2021) states that global non-cash transactions will grow at 18.6% CAGR during 2020-2025 with volumes of e-payments expected to reach near to 1.8 trillion. Use of EPS such as biometric, buy now, pay later (BNPL), invisible, and cryptocurrency are expected to occupy centre stagesoon.

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\* Professor, University Business School, Panjab University Regional Centre, Ludhiana, Punjab, India.  
\*\* Assistant Professor (Economics), SCD Government College, Ludhiana, Punjab, India.



EPS defined as the means of receiving and paying money through an electronic medium without the use of cash and cheque have not only changed the system of payment settlement, but has brought much bigger revolutions like e-commerce business, better integration of world economies, formalisation of business, making financial services reach to people who hitherto were unbanked. Though EPS have covered a great mileage, it is pertinent to mention here that still a large segment of society shy away from using them.

### Indian E Payment Scenario

Contours of Payment Industry are changing rapidly in India. Central bank of the country (RBI) is working rigorously to realise its vision of vesting every Indian with access to a bouquet of affordable, convenient, quick and safe e-payment options. In India, the volume of digital payments has shown tremendous growth from 1004 crore transactions in 2016-17, the number has gone up to 5554 crores in 2020-21 (Economic Times, 1-12-2021). With 624 billion internet users in 2021 which has shown growth of 8.2 percent over previous year and the internet penetration at 45 percent (digital report 2021), future of EPS is highly bright in India. The value of e-commerce transactions in India grew at 34.3 percent in one year and were \$74.04 billion in 2020-21. The modes of e-payment systems used in the country include online banking, credit cards, debit cards, IMPS, NEFT and RTGS. As per ACI Worldwide (Indian Express, 27 October, 2021) 60 percent people used digital payments numerous times in a week during festive season. Share of digital wallet users is at highest (41 percent) and share of debit and credit card payments was reported at 23 percent. A large chunk of the population is still not using the EPS due to lack of confidence in the safety, confidentiality and efficiency. Models such as Technology Acceptance Model, Diffusion of Innovation Theory, Unified Theory of Acceptance and Use of Technology (UTAUT 1 and UTAUT 2) etc have identified factors affecting use of EPS. In this study we have examined how the demographic characteristics of the users affect the adoption and use of EPS, objectives of the study are:

- To examine the status of use of EPS in India
- To examine the association between demographic characteristics of the users and the use of EPS.

### Review of Literature

**Lohana and Roy (2021)** in their study reported that gender and marital status of the respondents don't have significant impact on consumers' usage of EPS. **Vinitha and Vasantha (2017)** reported that variables Perceived Benefits, Perceived Speed and Facilitating conditions which affect the adoption of EPS are significantly influenced by demographic variables such as age, and occupation.

**Connolly and Stavins (2015)** reported that payment behaviour of the users is significantly associated with the users' demographics and income. **Stavins (2016)** reported that after controlling for education and age, income, education and minority status has direct association with the payment behaviour of users.

### Methodology

Both secondary and primary data has been considered. Secondary data is used to achieve the first objective of the study regarding status of use of e-payment systems in India. The secondary data is taken from CLSA report on digital payments. To achieve the second objective of the study, primary data regarding the perceptions of the users of e-payment systems is obtained using a structured questionnaire. Questionnaire is designed on the basis of review of literature and through interaction with bankers and other experts from the concerned field. 759 Respondents from Punjab, Haryana and Himachal Pradesh are interviewed. In order to examine the association between demographic variables of the user and use of EPS following null hypotheses were set:

- H<sub>1</sub>:** There is no significant association between the age of the respondent and percentage of payments made through EPS
- H<sub>2</sub>:** There is no significant association between the age of the respondent and his level of satisfaction with EPS
- H<sub>3</sub>:** There is no significant association between the age of the respondent and the convenience associated with the use of EPS
- H<sub>4</sub>:** There is no significant association between the respondent's area and percentage of payments made through EPS
- H<sub>5</sub>:** There is no significant association between the respondent's area and his level of satisfaction

with EPS

- H<sub>6</sub>:** There is no significant association between the respondent's area and the convenience associated with the use of EPS
- H<sub>7</sub>:** There is no significant association between respondent's occupation and percentage of payments made through EPS
- H<sub>8</sub>:** There is no significant association between the respondent's occupation and his level of satisfaction with EPS
- H<sub>9</sub>:** There is no significant association between the respondent's occupation and the convenience associated with the use of EPS
- H<sub>10</sub>:** There is no significant association between the respondent's qualification and percentage of payments made through EPS
- H<sub>11</sub>:** There is no significant association between the respondent's qualification and his level of satisfaction with EPS
- H<sub>12</sub>:** There is no significant association between the respondent's qualification and the convenience associated with the use of EPS
- H<sub>13</sub>:** There is no significant association between the respondent's income and percentage of payments made through EPS
- H<sub>14</sub>:** There is no significant association between the respondent's income and level of satisfaction with EPS
- H<sub>15</sub>:** There is no significant association between the respondent's income and the convenience associated with the use of EPS

Pearson's Chi-square( 2) test is used to examine the hypotheses. 2 is a widely used non-parametric test to test the association between two categorical variables (i.e., whether the variables are independent or related). Contingency table is used in this test to analyze the data.

$$\chi^2 = \sum_{i=1}^R \sum_{j=1}^C \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

where,

$\chi^2$  = Chi-square value

$o_{ij}$  is the observed cell count in the  $i^{\text{th}}$  row and  $j^{\text{th}}$  column of the table

$e_{ij}$  is the expected cell count in the  $i^{\text{th}}$  row and  $j^{\text{th}}$  column of the table, computed as

$$e_{ij} = \frac{\text{row } i \text{ total} * \text{col } j \text{ total}}{\text{grand total}}$$

## Data Analysis and Results

### Status of Use of Electronic Payment Systems

As electronic payment systems deal with money therefore people are highly concerned about the safety and confidentiality these systems offer, pros and cons of using EPS. The aspects considered to analyse the status of adoption of electronic payment systems in the country include use of EPS in India as compared to the global level, the popularity of various modes of EPS and the main users the UPI platforms.

- **Country wise Status of Adoption of Electronic Payment Systems**

In order to assess the extent of use of EPS in India, data regarding the value of real time payments(2020) made in top ten users of the world are presented in table 1.

**Table 1: Country wise use of Real Time Payment Systems (RTGS)**

Sr. No.	Country	Value (Fig. in Billion US\$)
1	India	25.5
2	China	15.7
3	South Korea	6
4	Thailand	5.2
5	UK	2.8
6	Nigeria	1.9



7	Japan	1.7
8	Brazil	1.3
9	US	1.2
10	Mexico	0.9

Source: CLSA, Digital Payment Report 2020, as quoted in TOI, 30<sup>th</sup> Dec., 2021

India was leading the world in the use of real time payment systems (US\$ 25.5 billion) in the year 2020 followed by China (US\$ 15.7). The value of real time transactions performed in India was highest, 162 percent of the value of transactions completed in country coming at number 2. The value of real time transactions conducted in US in 2020 was much less at US\$ 1.2 billion only.

- **Types of Electronic Payment Modes Used in India**

Data regarding use of different modes of EPS like cards, online banking, mobile banking, digital wallets for the year 2020 is presented in table 2.

**Table 2: EPS Modes Used in India**

Sr. No	Mode of E-Payment	Percentage of Transactions
1	UPI and Digital Wallets	40
2	Debit Card	15
3	Credit Card	15
4	Bank Transfers	13
5	Others(Including Online Banking)	17

Source: CLSA, Digital Payment Report 2020, as quoted in TOI, 30<sup>th</sup> Dec., 2021

In 2020, most favourite method of EPS in India was the UPI and digital wallets with 40 percent share in electronic payments followed by debit and credit cards each with 15 percent share. Out of the payments made through EPS, 13 percent were done through bank transfers. The main reason behind the use of digital wallets is that they are highly quick and convenient method as they allow to release the payment 24 hours in a day and 7 days in a week.

- **UPI Bank Beneficiaries**

Unified Payments Interface (UPI) designed and launched in April 2016 provides the facility of combining multiple bank accounts into a single mobile application and caters to the "Peer to Peer" collect request. Data of UPI Bank beneficiaries is presented in table 3:

**Table 3: UPI Beneficiary Market Share**

Sr. No	Player	Share in Percentage
1	SBI	16
2	Yes Bank	12
3	ICICI Bank	11
4	Axis Bank	8
5	HDFC Bank	6
6	Bank of Baroda	3

Source: CLSA, Digital Payment Report 2020, as quoted in TOI, 30<sup>th</sup> Dec., 2021

Main beneficiary among the banks of UPI app is State Bank of India with a market share of 16 percent (table 3), followed by Yes Bank (12 percent). ICICI Bank has market share of 11 percent, Axis Bank (8 percent) and HDFC Bank 6 percent market share on this app.

- **Share of Digital Wallets on UPI App**

Data of the market share of various digital wallets such as Phonepe, Google Pay, Paytm, Amazon Pay, CRED and BHIM on UPI App is presented in table 4:

**Table 4: Share of Digital Wallets in UPI app Market**

Sr. No	Player	Share in Percentage
1	Phonepe	43
2	Google Pay	43
3	Paytm	8
4	Amazon Pay	1
5	CRED	1
6	BHIM	2
7	Others	2

Source: CLSA, Digital Payment Report 2020, as quoted in TOI, 30<sup>th</sup> Dec., 2021

Two digital wallets Phonepe and Google Pay has maximum market share of 43 percent each(table 4) on UPI app. Paytm has a very low share of 8 percent.

### Respondent's Demographics and Adoption of Electronic Payment System

The adoption of new and innovative EPS is dependent upon number of factors. One category of such factors are the demographics of the users. An analysis of the association between demographic characteristics such as age, income, area (rural, semi-urban or urban), qualification and occupation of the respondent with the adoption of EPS is made. Association of the demographic variables is examined using three perspectives i.e. how frequently user is using the e-payments system, users level of satisfaction with e-payment system and respondents satisfaction with the efficiency of the EPS.

#### Respondent's Age and Use of EPS

Normally, people are of the view that young people show more risk in trying new and innovative products and services as compared to old people. Results of the association between respondents' age and extent of use of EPS are presented in table 5:

**Table 5: Respondent's Age and Use of EPS**

Age	Payments Made through EPS on Monthly Basis						Total
	0-5%	6-15%	16-25%	26-35%	36-45%	Above 45%	
15-25	57	51	43	41	37	96	325
26-35	6	17	18	29	35	123	228
36-45	9	6	8	16	16	55	110
46-55	15	3	8	10	12	21	69
Above 55	10	2	3	7	3	2	27
Total	97	79	80	103	103	297	759

$\chi^2=1.017$ , p Value =0.000, N =759

Source: Survey Method

Highest number of respondents 297(table 5) out of 759 are already settling more than 45 percent of their payments through EPS. Among the 297 respondents, highest number 123 respondents from the age group of 26 to 35 are settling more than 45 percent of their payments through EPS. Null hypothesis H1 stands rejected as indicated by the test statistic value of 1.017 with corresponding p Value of 0.000.

#### Respondent's Age and Satisfaction with EPS

Association between the age of the respondent and his level of satisfaction, is examined with the help of  $\chi^2$ . The results of the test are presented in table 6.

**Table 6: Respondent's Age and Satisfaction with EPS**

Age	Satisfaction with EPS					Total
	Highly Dissatisfied	Dissatisfied	Neutral	Satisfied	Highly Satisfied	
15-25	1	3	47	163	111	325
26-35	1	0	10	175	42	228
36-45	2	0	18	58	32	110
46-55	0	4	14	35	16	69
Above 55	0	1	11	14	1	27
Total	4	8	100	445	202	759

$\chi^2= 94.239$ , p Value = 0.000, N= 759

Source: Survey Method

Table 6 shows that young people (age group 15-25 years) are comparatively more satisfied with the use of EPS as out of 325 total respondents, 274(163+111) i.e. 84.31 percent are in the satisfied and highly satisfied category. Similarly, from the age group 26 to 35 years, 217(95.17 percent) out of total 228 are either satisfied or highly satisfied, whereas in the upper age groups the percentage of respondents falling in satisfied and highly satisfied category are much less.  $\chi^2$  results with test statistic value of 94.239 and corresponding p Value of 0.000 shows that the null hypothesis H2 stand rejected verifying that young people derive comparatively more satisfaction from EPS.

- **Respondent's Age and Efficiency of Electronic Payment Systems**

One of the major advantages for which people prefer to use EPS is that these modes help in quick transfer of money and are also comparatively less costly. The views of people from different age groups about the efficiency of EPS are examined:

**Table 7: Respondent's Age and Efficiency of EPS**

Age	EPS is Quick and Saves Time					Total
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
15-25	0	2	8	116	199	325
26-35	0	0	3	138	87	228
36-45	2	2	3	56	47	110
46-55	0	3	10	31	25	69
Above 55	0	1	8	16	2	27
Total	2	8	32	357	360	759

$\chi^2 = 1.381, p \text{ Value} = 0.000, N = 759$

Source: Survey Method

A large majority of 717 respondents (table 7) out of total 759 respondents have agreed and strongly agreed that EPS takes comparatively less time and saves resources.  $\chi^2$  results with  $\chi^2$  value of 1.381 and p Value of 0.000 shows that the null hypothesis H3 stands rejected verifying that there is significant association between the age of the respondent and his views about the efficiency of EPS. Table shows that the proportionate number of young people who feel that EPS are efficient both in term of usage of time and other resources is higher as compared to aged respondents.

- **Respondent's Area of Residence and His Perceptions about EPS**

There is a huge gap between the infrastructural facility with respect to internet connectivity and speed available in rural and urban areas. The results of association between the area of residence of the respondent and his satisfaction from EPS and the efficiency of EPS are discussed in this section:

- **Respondent's Area of Residence and Use of EPS**

In this part, we have analysed the association between the area of residence of the respondent and extent of use of EPS.

**Table 8: Respondent's Area and Use of EPS**

Area	Payments Made through EPS on Monthly Basis						Total
	0-5%	6-15%	16-25%	26-35%	36-45%	Above 45%	
Urban	52	51	54	69	84	214	524
Semi Urban	14	9	6	16	12	50	107
Rural	31	19	20	18	7	33	128
Total	97	79	80	103	103	297	759

$\chi^2 = 42.155, p = 0.000, N = 759$

Source: Survey Method

Out of 524 respondents (table 8) from urban areas, 298 (56.87 percent) respondents are making more than 36 percent of their payments through EPS and in case of rural areas 48 (37.5 percent) respondents out of total 128 respondents made more than 36 percent payments through EPS.  $\chi^2$  with test value of 42.155 and p Value of 0.000 shows that the null hypothesis H4 stands rejected verifying that area of residence and use of EPS are related with each other and people from urban area make more use of EPS.

- **Respondent's Area of Residence and Satisfaction with EPS**

In this section, as analysis of the association between the area of residence of the user with the level of satisfaction obtained from the use of EPS is examined.

**Table 9: Respondent's Area and Satisfaction with EPS**

Area	Satisfaction with EPS					Total
	Highly Dissatisfied	Dissatisfied	Neutral	Satisfied	Highly Satisfied	
Urban	3	4	61	308	148	524
Semi Urban	1	1	11	67	27	107
Rural	0	3	28	70	27	128
Total	4	8	100	445	202	759

$\chi^2 = 15.153, p \text{ Value} = 0.056, N = 759$

Source: Survey Method



Results of  $\chi^2$  with test statistic value of 15.153 and p Value of 0.056 (table 9) states that the null hypothesis H5 stands accepted verifying that the level of satisfaction derived by the users coming from different categories of areas are not associated.

- **Respondent's Area of Residence and Efficiency of EPS**

People prefer to use EPS as these systems are considered more efficient. Therefore, in this section of the study whether the views of the respondents from urban and rural areas are same or different are examined. Data and the results of  $\chi^2$  are presented in table 10:

**Table 10: Respondent's Area and Efficiency of EPS**

Area	EPS is Quick and Saves Time					Total
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Urban	0	6	19	270	229	524
Semi Urban	2	1	0	48	56	107
Rural	0	1	13	39	75	128
Total	2	8	32	357	360	759

$\chi^2 = 43.255$ , p Value = 0.000, N = 759

Most of the respondents irrespective of the area they come from have stated either that they agree or strongly agree with the statement that EPS are quick, save resources and are more efficient (table 10). Null hypothesis H6 stands rejected as indicated by the test statistic value of ( $\chi^2$ ) of 43,255 and p Value of 0.000 verifying that the views of the users about the efficiency of EPS are associated with the area they belong.

- **Respondent's Occupation and Adoption of EPS**

The thought process of the people in respect to adoption of EPS may vary according to their occupation. Therefore, an effort is made to check the association of respondent's occupation with extent of use of EPS, satisfaction derived from the use of EPS and views about the efficiency of EPS.

- **Respondents Occupation and Extent of use of EPS**

Data and the results of  $\chi^2$  regarding the association between the occupation of the respondents and the extent to which they are making use of EPS are presented in table 11.

**Table 11: Respondent's Occupation and Use of EPS**

Occupation	Payments Made through EPS on Monthly Basis						Total
	0-5%	6-15%	16-25%	26-35%	36-45%	Above 45%	
Student	57	53	46	48	43	122	369
Serviceman	10	11	16	24	36	131	228
Businessman	5	4	8	16	15	20	68
Housewife	6	2	1	3	0	1	13
Others	19	9	9	12	9	23	81
Total	97	79	80	103	103	297	759

$\chi^2 = 98.496$ , p Value = 0.000, N = 759

Source: Survey Method

From the category of students, 122(33 percent) are making more than 45 percent of their payments through EPS, 43(11.65 percent) are making 36 to 45% of their payments through EPS (table 11). In the serviceman category, 131 have used EPS for making more than 45 percent payments, in the category of businessmen, 20 (29.41 percent) respondents made more than 45 percent of their payments through EPS. Null hypothesis H7, as indicated by the  $\chi^2$  value of 98.496 and p Value of 0.000 stands rejected verifying that there is significant association between the occupation of the respondent and the extent of EPS used.

- **Respondent's Occupation and Satisfaction with EPS**

Results regarding association of respondent's occupation and their level of satisfaction with EPS are given in the table 12:

**Table 12: Respondent's Occupation and Satisfaction with EPS**

Occupation	Satisfaction with EPS					Total
	Highly Dissatisfied	Dissatisfied	Neutral	Satisfied	Highly Satisfied	
Student	1	3	49	202	114	369
Serviceman	2	1	15	147	63	228
Businessman	1	3	9	47	8	68
Housewife	0	0	9	4	0	13
Others	0	1	18	45	17	81
Total	4	8	100	445	202	759

$\chi^2 = 72.754$ , p Value = 0.000, N = 759

Source: Survey Method

445 respondents out of 759 are satisfied and 202 are highly satisfied with the use of EPS. Number of respondents (table 12) found satisfied and highly satisfied with EPS are more in the category of students and servicemen as compared to other occupations.  $\chi^2$  value of 72.754 with corresponding p Value of 0.000 shows that the null hypothesis H8 is rejected, proving that occupation of the user and the level of satisfaction derived from the use of EPS are associated.

- **Respondent's Occupation and Efficiency of EPS**

Data and the results of  $\chi^2$  regarding association between the occupation of the users and their views regarding the efficiency of EPS are presented in table 13.

**Table 13: Respondent's Occupation and Efficiency of EPS**

Occupation	EPS is Quick and Saves Time					Total
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Student	0	2	8	150	209	369
Serviceman	0	1	4	116	107	228
Businessman	0	4	2	54	8	68
Housewife	0	0	5	8	0	13
Others	2	1	13	29	36	81
Total	2	8	32	357	360	759

$\chi^2 = 1.569$ , p Value = 0.000, N = 759

Source: Survey Method

Table 13 shows that number of students and servicemen who agree and strongly agree with the statement that EPS are comparatively more efficient are higher.  $\chi^2$  value of 1.569 with corresponding p Value of 0.000 shows that the null hypothesis H9 stands rejected.

**Respondent's Qualification and Use of EPS**

Since the use of EPS require some knowledge about internet and methods of EPS, therefore less educated people may not be interested in using the EPS.

- **Respondent's Qualification and Extent of Use of EPS**

Data and results of  $\chi^2$  regarding association between the qualification of the users and use of EPS is presented in table 14.

**Table 14: Respondent's Qualification and Use of EPS**

Education	Payments Made through EPS on Monthly Basis						Total
	0-5%	6-15%	16-25%	26-35%	36-45%	Above 45%	
Matric	30	10	4	12	9	12	77
Graduation	62	65	76	84	91	271	649
Post- Graduation and above	5	4	0	7	3	14	33
Total	97	79	80	103	103	297	759

$\chi^2 = 68.591$ , p Value = 0.000, N = 759

Source: Survey Method

271(41.76 percent) graduates are making more than 45 percent payments through EPS and 14(42.42 percent) post graduate and above qualified respondents are making more than 45 percent payments through EPS, whereas only 12(15.58 percent) respondents who are matriculate are making more than 45 percent payments through EPS (table 14).  $\chi^2$  results with value of 68.591 and p Value of 0.000 shows that the null hypothesis H10 stands rejected verifying that users with higher qualification make more use of EPS.

- **Qualification of the Respondent and Satisfaction with EPS**

The data and the results of  $\chi^2$  test regarding association between the respondent's qualification and the level of satisfaction derived from EPS are presented in table 15.

**Table 15: Respondent's Education and Satisfaction with EPS**

Education	Satisfaction with EPS					Total
	Highly Dissatisfied	Dissatisfied	Neutral	Satisfied	Highly Satisfied	
Matric	0	2	34	31	10	77
Graduation	4	5	60	395	185	649
Post-Graduation and Above	0	1	6	19	7	33
Total	4	8	100	445	202	759

$\chi^2 = 80.063$ , p Value = 0.000, N = 759

Source: Survey Method

Table 15 shows that 395 and 185 graduate respondents out of 649 are respectively satisfied and highly satisfied with the use of EPS. 31 and 10 matric pass out of a total of 77 are respectively satisfied and highly satisfied with EPS.  $\chi^2$  results with test statistic value of 80.063 and p Value of 0.000 shows that the null hypothesis H11 is rejected.

- **Qualification of Respondent and Efficiency of EPS**

Table 16 presents the data about the qualification of the respondents and their views about the efficiency of EPS.

**Table 16: Respondent's Education and Efficiency of EPS**

Education	EPS is Quick and Saves Time					Total
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Matric	2	2	18	31	24	77
Graduation	0	5	13	315	316	649
Post-Graduation and Above	0	1	1	11	20	33
Total	2	8	32	357	360	759

$\chi^2 = 1.040$ , p Value = 0.000, N = 759

Source: Survey Method

$\chi^2$  value of 1.040 with corresponding p Value of 0.000 (table 16) leads to rejection of null hypothesis H12, verifying that respondent's education and views about efficiency of EPS are associated.

### Respondents Income and EPS

People from low-income category generally hesitate to use EPS as these methods deal with money directly. Therefore, association of income level of the respondents and their views regarding extent of use of EPS, Level of satisfaction derived from EPS and views about efficiency of EPS are examined.

- **Respondent's Income and Use of EPS**

The views of the respondents categorised as per their income regarding the extent to which they use EPS to settle their transactions on monthly basis are presented in table 17.

**Table 17: Respondent's Income and Use of EPS**

Income	Payments Made through EPS on Monthly Basis						Total
	0-5%	6-15%	16-25%	26-35%	36-45%	Above 45%	
0	16	6	5	8	2	14	51
Less than Rs. 70000	43	50	36	46	40	101	316
Rs. 70001 to Rs. 273000	17	12	11	11	15	64	130
Rs. 273001 to Rs. 846000	16	4	19	19	24	83	165
Rs. 846001 and above	5	7	8	19	22	36	97
Total	97	79	79	103	103	298	759

$\chi^2 = 72.383$ , p Value = 0.000, N = 759

Source: Survey Method



It can be seen that 36(37.11 percent) from the highest income bracket of above Rs. 846001 are making more than 45 percent of their payments through EPS, whereas the number of such respondents from the no income category is 14(27.45 percent). In the income category group of less than Rs, 70000, 101(31.96 percent) respondents made more than 45 percent of their monthly payments through EPS.  $\chi^2$  value of 72.383 with corresponding p Value of 0.000 indicates that the null hypothesis H13 is rejected.

- **Respondent's Income and Satisfaction with EPS**

Data regarding income level of the respondents and the level of satisfaction derived from the use of EPS is presented in table 18.

**Table 18: Respondent's Income and Satisfaction with EPS**

Income	Satisfaction with EPS					Total
	Highly Dissatisfied	Dissatisfied	Neutral	Satisfied	Highly Satisfied	
0	0	0	10	27	14	51
Less than Rs. 70000	1	5	44	163	103	316
Rs. 70001 to Rs. 273000	0	0	20	77	33	130
Rs. 273001 to Rs. 846000	2	3	13	113	34	165
Rs. 8460001 and above	1	0	12	65	19	97
Total	4	8	99	445	203	759

$\chi^2 = 28.446$ , p Value = 0.028, N = 759

Source: Survey Method

$\chi^2$  test statistic value of 28.446 with corresponding p value of 0.028 (table 18) shows that the null hypothesis H14 stands rejected at 5% significance level concluding that the level of income of the respondent and his satisfaction with the EPS are associated.

- **Respondent's Income and Efficiency of EPS**

Data regarding income level of the respondents and their views about the efficiency of EPS measured in terms of time taken to settle the payments and resources utilised are presented in table 19.

**Table 19: Respondent's Income and Efficiency of EPS**

Income	EPS is Quick and Saves Time					Total
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
0	0	0	2	17	32	51
Less than Rs. 70000	2	4	12	115	183	316
Rs. 70001 to Rs. 273000	0	1	9	60	60	130
Rs. 273001 to Rs. 846000	0	2	7	96	60	165
Rs. 8460001 and above	0	1	2	68	26	97
Total	2	8	32	356	361	759

$\chi^2 = 54.54$ , p Value = 0.000, N = 759

Source: Survey Method

$\chi^2$  value 54.54 with corresponding p Value shows that the null hypothesis H15 stands rejected, verifying that the income level of the respondent and his views about the efficiency of EPS are related.

### Concluding Remarks

EPS have shown rapid increase in their use across the world, but trend of use of EPS is not consistent and a large chunk of population from all categories urban and rural, educated and less educated, rich and poor, are still not making use of these systems. Therefore, in this study an attempt was made to examine the trend of use of EPS in India and also to examine whether there is any association between user demographics and their adoption of EPS.

So far as, India's standing in the international community regarding adoption of EPS is concerned, India is the highest user of RTGS, with highest value of transactions of worth US\$25.5 billion conducted in 2020. Good internet services at low price available in wider area covering large population, larger penetration of smartphones may be the reasons. Most preferred mode in India is digital wallets with almost 40 percent market share. People in India mostly use Phonepe and Google pay with each having market share of 43 percent. Young and urban area people make comparatively more use of EPS, are comparatively more satisfied and consider EPS highly efficient. Students and servicemen use more of EPS as compared to users from business category. Educated and rich people make more use of EPS.

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