


**A STUDY ON IMPACT OF OPEN INNOVATION OPENNESS ON THE PRACTICES  
ADOPTED BY INDIAN FOOD PROCESSING SMES ON PRODUCT INNOVATION OUTPUT**

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### **Abstract**

This study throws light on the outline of innovation taking place in Indian Food Processing SMEs with a special focus on open Innovation taking place in these SMEs and the exchange of information or knowledge taking place between inside-out and outside-in parties for the purpose of innovation. In addition, puts special focus on describing how SMEs' product innovation output related with the effect of outside-in and inside-out exchange of knowledge and information. Further, it analyzes how expenditure on innovation and collaborating with outside parties can help in the predicting product innovation output of Indian Food Processing SMEs. The analysis was done with the help of Jamovi to find out regression between the dependent variable- "Product innovation output" & independent variables- "Extent of openness", "Inhouse R& D expenditure", "Purchase of R&D from outside sources", "Acquiring knowledge from outside sources" and control variable- "Indian Food Processing SMEs". And towards the end, it contains the summary of the survey done, which suggested that Indian Food Processing SMEs are proactively involved themselves in inside R&D in comparison to the outside R&D and buying or taking license from outside sources. Other than these activities, one more pointer came as a takeaway from the study, product innovation is performed more in comparison to process innovation by the Indian Food Processing SMEs.

### **Keywords**

open innovation; open innovation openness; product innovation; innovation output; India; food processing SMEs.

### **Introduction**

Numerous researchers have already been doing innovation, from arranging a surprise party to a giving idea. It has always been in the form of involving friends and collecting ideas. It has gradually become bigger set-up, after emerging social media. In industries, no doubt closed innovation models were more controlled and worked well, but after the new management practices like delegation, collaboration and taking risk came within the culture of organizations. The only choice left is to move from closed to open innovation models. There are still many companies which are relying upon developing core strengths and developing and protecting their intellectual properties. Researchers suggest that it is not easy to set up open innovation. Open innovation is a systemic shift that wants to think many aspects of one's business to use it effectively. R&D alone cannot fully conduct open innovation. Other parts of the organization, in marketing, in business development,

functions like human and resource management, must get on board for it to work effectively. Formal documentation of open innovation helps but growing a culture that supports open innovation is equally important for its effectiveness [1]. “Open Innovation is about bridging internal and external resources and act on those opportunities” [2]. “Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology” [3]. “Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. This paradigm assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology” [4]. Open innovation means treating innovation like anything else — something that can be bought and sold on the open market, not just produced, and used within the boundaries of the firm. Open innovation is using the market internal hierarchies to source and commercialize innovations. Presently worldwide organizational leaders see collaboration as a key to innovation but achieving innovation targets using internal resources only has turned disbelief for most of them. Numerous of them realized that it is about harnessing external resources. Many corporates like P&G, IBM, Unilever, Reckitt Benckiser, and BMW etc. have opted for this way of innovation a long before, with seamless positive results. They have experienced fast processing, reduced cost, more innovative ideas under a roof and lessened launch time for any product [5]. Julian Keith Loren states that open innovation is as powerful as expanding the horizon for design capacities, strengthened commercialization and from here increasing profits. Open innovation as an idea for organizations is as near as it penetrates organizational walls, transforms business models and thus enabling a business to the edge and ahead of competitors [6]. Van de Vrande et al. [7] explored whether SMEs use open innovation approaches. Open innovation applies to a much larger number of SMEs than only MNEs. Focused on technological exploitation and indicated that many SMEs try to gain from their (non-R&D) employees' efforts and knowledge. When it comes to technological exploration, most SMEs aim to include their consumers in the process in some form, such as tracking product improvements, proactively incorporating them in market research, etc. Furthermore, acquiring new or missing information through external networking is a key open innovation activity for SMEs. Outward and inward IP licensing, venture capital, and external participation, on the other hand, are only used by a small percentage of SMEs. Customer interaction and external networking, for example, are informal, unstructured behavior that may not always necessitate large investments. Tranekjer and Knudsen [8] concentrated on two research questions: In the first place, who and why do outsiders contribute information for open innovation? What drives people and businesses to generate and freely share information that can benefit other (even competitive) innovators? As suppliers, providers participate in product development initiatives and gain from offering services (in the form of their own knowledge development and innovation efforts). The provider is usually a customer or a supplier of the receiver company, although not always. Pullen et al. [9] investigated whether network features contribute to high innovation performance, and his findings showed that a business-like attitude to networking and a closed approach to open innovation are associated to high innovation performance. Goal complementarity should be emphasized upon. Parida, Westerberg, and Frishammar [10] shed light on which open innovation initiatives SMEs might participate in to kickstart their own innovation efforts. Future research on the issue of open innovation should include innovation performance as a dependent variable, and inbound open innovation activities should have different effect patterns on the two components radical and incremental of innovation performance.

#### Indian MSMEs

For the developing economy of India, SMEs are the backbone and has majorly supported the growth. To India's GDP SMEs has contributed 29.7%, gives employment to approx. 11 crore people and 49.66% to Indian exports and 45% to the manufacturing output. And during the COVID-19 pandemic, the Indian SMEs were worst affected as trade came to standstill and the supply chains were disturbed in the entire World. Unconventional support systems and initiatives were introduced and implemented during year 2020 by the Ministry of MSME. Few of these were-redefining the definition of SMEs, offering financial support system through fund of funds, developing IT infrastructure for offering answers to the problems faced by the SMEs and more. The money allocated under the Union Budget was doubled for MSMEs to ₹15,700 crore for 2021-22 year. Recently, Indian SMEs had the attention because Government of India has realized their important position in the economy. Even after remarkable contributions to India's economy, SMEs continue to encounter several hurdles. One of them is to keep upgrading their technologies with the rapid changes taking place these days and then bearing the risk of these technologies becoming obsolete. To achieve the goals set under the Atmanirbhar Bharat, there is a dire need to go for strong, bold, and swift structural changes accompanied with modernizing the Indian SMEs. As per India's Hon'ble Prime Minister, Narendra Modi ji—skill, reskill and upskill, SMEs need to work on upgrading their skills. Several studies by the research bodies and academic institutions have thrown light on the importance

of digital tools and how the same can be utilized by the Indian SMEs to further hike their incomes by 34%. India as a developing country has the capacity to acquire the position of a strong economic power, with the help and contribution of SMEs in production, exports to other countries, promoting the spirit of entrepreneurship and no doubt, generating employment. Government of India has announced their budget for the year 2021 under which consideration has been given to the upliftment of SMEs sector and special focus has been put on their growth.

India improved its ranking from 81 in 2015 to 48 in 2020, marking the first time since the Global Innovation Index's establishment in 2007 that India has reached the top 50 inventive countries. According to the Economic Survey 2020-21, India ranks first in Central and South Asia and third among lower middle-income nations. According to the Economic Survey 2020-21, India must put more emphasis on innovation to propel itself to a higher growth trajectory and become the third biggest economy in terms of GHDP current US\$ soon. This will need increasing gross R&D spending from its present level of 0.7 percent of GDP to at least the average level of Gross Domestic Expenditure on (GERD) in other top ten nations (GDP current US\$). According to the Economic Survey 2020-21, the government sector accounts for a disproportionately big amount of total GERD, accounting for three times the average of comparable large countries. However, the contribution of the private sector to GERD is among the lowest in India. The contribution of the private sector to overall R&D staff and researchers is similarly lower than in other big economies. Despite having more flexible tax incentives for innovation than other economies, this condition has endured. For its amount of access to equity capital, India's innovation score is far lower than projected. This emphasizes the necessity for India's business sector to increase R&D spending. For its amount of access to equity funding, India's performance on Innovations has been lower than predicted. The Economic Survey 2020-21 emphasized the need to increase the contribution of the business sector to total GERD from the present 37 percent to close to 68 percent. According to the survey, the sectors' overall R&D contribution should be increased from 30 percent and 34 percent research personnel, respectively, to 58 percent and 53 percent, respectively [11].

Entrepreneurs, according to the vision of the Hon'ble Prime Minister, Shri Narendra Modi, are the foundation of the social change that India aspires to, and their efforts will lay the foundation for a New India, fill in the gaps in solutions required by the people, and help build the foundation for constructing a powerful India's economic structure. The Ministry of Micro, Small and Medium Enterprises is working to enable MSMEs to put their thinking caps on and create innovative solutions as part of the #IdeasforNewIndiaChallenge2020, while also looking for local solutions to local problems, which could be the generation leap India needs to transform its social, cultural, and economic ecosystem into a world leader. Under the Office of Development Commissioner – MSME's initiative for Support for Entrepreneurial and Managerial Development of MSMEs via Incubators, ideas for a New India are being sought from innovators, start-ups, technocrats, students, and MSMEs from all over India. And each accepted concept would receive monetary support of up to Rs. 15 lakhs [12].

#### Objectives and Research Methodology

Following are few tables throwing light on the Indian Food Processing SMEs:

Table 1. Gross value added (GVA) by food processing industries (FPI) at constant 2011-2012 prices (₹ in lakh crore).

*Source: Annual Survey of Industries (ASI 2016-17).*

<b>Gross value added (GVA) by food processing industries (FPI) at constant 2011-2012 prices (₹ in lakh crore)</b>							
S. No.	Economic Activity	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
1	GVA-All India	90.64	97.12	104.92	113.28	120.74	128.03
2	Percentage share of food processing in GVA-Manufacturing	8.34	7.96	8.46	8.71	8.72	8.98
3	Percentage share of food processing in GVA-Agriculture, Forestry and Fishing	8.09	8.34	9.96	10.37	10.45	11.11

Table 2. Key features of registered food processing industries. *Source: Annual Survey of Industries (ASI 2016-17).*

Key features of registered food processing industries						
Rank	Total No. of Factories	No. of Factories in Operation	Fixed Capital	Total Persons Engaged	Output	Gross Value Added
1	Food Products (15.95%)	Food Products (16.78%)	Basic Metals (20.54%)	Food Products (11.36%)	Food Products (14.09%)	Coke & Refined Petroleum Products (12.87%)
2	Other Non-Metallic Mineral Products (11.92%)	Other Non-Metallic Mineral Products (12.13%)	Other Industries (13.34%)	Textiles (10.46%)	Coke & Refined Petroleum Products (12.06%)	Chemicals & Chemical Products (9.95%)
3	Textiles (7.54%)	Fabricated Metal Products, except Machinery and Equipment (7.33%)	Coke & Refined Petroleum Products (12.88%)	Wearing Apparel (7.63%)	Basic Metals (11.53%)	Basic Metals (8.12%)
4	Fabricated Metal Products (7.46%)	Textile (7.02%)	Chemicals & Chemical Products (8.96%)	Other Non-Metallic Mineral Products (7.24%)	Chemicals & Chemical Products (8.02%)	Motor Vehicles, Trailers & Semi-Trailers (7.68%)
5	Rubber & Plastic Products (5.97%)	Rubber & Plastic Products (5.70%)	Other Non-Metallic Mineral Products (6.16%)	Motor Vehicles, Trailers & Semi-Trailers (6.62%)	Motor Vehicles, Trailers & Semi-Trailers (7.74%)	Food Products (7.60%)
Aggregate Total (all industries)	234865	194380	319038649	14911189	726551423	136805049

Table 3. Employment in food processing industry. *Source: Annual Survey of Industries 2017-18, NSSO Report No. 582 (73/2.34/2) on Economic Characteristics of Unincorporated Non-Agricultural Enterprise, NSSO 73 Round (July 2015-June 2016)*

Employment in food processing industry			
Sector	Food Processing Industry	Overall Industry	(%) Share of Food Processing sector
Registered (2017-18)	19.33 lakh	156.14 lakh	12.38
Un-incorporated (2015-16)	51.11 lakh	360.41 lakh	14.18

Table 4. Sub – sector wise key parameters of registered food processing industries (₹ in crore).

Source: ASI (2016-17).

Sub – sector wise key parameters of registered food processing industries (₹ in crore)									
Code (4 digits NIC, 2008)	Items	No. of Factories	No. of Persons Engaged	Fixed Capital (FC)	Total Output	Total Input	GVA	FC per Factory	GVA% (GVA / Input)
1010	Processing and preserving of meat	181	29812	2794	24846	23088	1758	15.43	7.62
1020	Processing and preserving of fish, crustaceans, mollusks, and products thereof	535	70298	4502	38388	3411	34977	8.41	9.75
1030	Processing and preserving of fruit and vegetables	1254	80440	8108	21830	4759	17070	6.47	27.88
1040	Manufacture of vegetable and animal oils and fats	3112	97888	17890	204537	196832	7705	5.75	3.91
1050	Manufacture of dairy products	2039	171497	22429	153260	140769	12491	11	8.87
1061	Manufacture of grain mill products	18899	345200	22769	253775	235801	17975	1.2	7.62
1062	Manufacture of starches and starch products	629	27352	5100	11266	9696	1570	8.11	16.19
1071	Manufacture of bakery products	1767	113043	5955	25704	20245	5459	3.37	26.96
1072	Manufacture of sugar	741	227890	62505	100672	83376	17296	84.35	20.74
1073	Manufacture of cocoa, chocolate and sugar confectionery	594	46253	8572	17898	13390	4508	14.43	33.67
1074	Manufacture of macaroni, noodles, couscous and similar farinaceous products	118	10048	2224	3267	2517	750	18.85	29.79
1075	Manufacture of prepared meals and dishes	323	27347	1215	7196	2820	4376	3.76	155.16
1079	Manufacture of other food products n.e.c.	6300	387742	22749	111557	93371	18186	3.61	19.48
1080	Manufacture of prepared animal feeds	976	58927	7150	49686	45993	3693	7.33	8.03
1101	Distilling, rectifying and blending of spirits; ethyl alcohol production from fermented materials	414	57760	12247	29491	23246	6245	29.58	26.87
1102	Manufacture of wines	77	6981	833	3359	2522	837	10.81	33.19
1103	Manufacture of malt liquors and malt	123	29471	6145	12303	9419	2884	49.96	30.61
1104	Manufacture of soft drinks; production of mineral waters and other bottled waters	1658	65903	12859	25955	18460	7495	7.76	40.6
TOTAL		39740	1853852	226045	1094990	973592	121397	5.69	12.47

Table 5. Indian's share in global food trade. *Source: ITC Trade Map, April 2019 (US\$ Million).*

Indian's share in global food trade					
	2014	2015	2016	2017	2018
World food export	1448249	1304999	1325686	1433363	1471089
World food import	1459121	1333359	1336423	1445982	1505428
India's food export to world	37744.21	30417.56	29199.88	34434.32	34023.88
India's food import from world	19284.52	20783.16	21939.09	25064.67	19561.08
% Share of India's food export in world	2.61%	2.33%	2.20%	2.40%	2.31%
% Share of India's food import in world	1.32%	1.56%	1.64%	1.73%	1.30%

Table 6. Year – wise fixed capital deployment in registered factories in Food Processing Industries.

Year-wise fixed capital deployment in registered factories in Food Processing Industries	
Year	Fixed Capital (₹ in crore)
2010-11	120705
2011-12	145038
2012-13	158865
2013-14	168380
2014-15	191984
2015-16	206339
2016-17	226043
2017-18	245063

Table 7. FDI equity inflow to FPI. *Source: Department for Promotion of Industry and Internal Trade.*

FDI equity inflow to FPI			
S. No.	Year (April-March)	FDI (In ₹crore)	FDI (US\$ Million)
1	2010-11	860.99	188.67
2	2011-12	859.02	170.21
3	2012-13	2,193.65	401.46
4	2013-14	25,106.77	3,982.89
5	2014-15	3,164.72	515.86
6	2015-16	3,312.00	505.88
7	2016-17	4,865.85	727.22
8	2017-18	5,835.62	904.9
9	2018-19	4,430.44	628.24
10	2019-20	3,241.76	463.44

After Focused Group Discussion with 28 experts from the Indian Food Processing Industry, survey method was adopted to study the objectives of innovation in Indian Food Processing SMEs, activities related to innovation in these SMEs. A structured questionnaire based on the feedback received from industry experts was adopted and modified to examine research objectives. The constructed tool used is -Innovation Survey of Indian Food Processing SMEs

[https://docs.google.com/forms/d/e/1FAIpQLSfDS1ld\\_g6US9l1Kk-hlo0bpEE8QVStG8YEFjXWUkzld1A8g/viewform](https://docs.google.com/forms/d/e/1FAIpQLSfDS1ld_g6US9l1Kk-hlo0bpEE8QVStG8YEFjXWUkzld1A8g/viewform)

## Innovation Survey of Indian Food Processing SMEs

- a. this survey collects information on your enterprise's innovations and innovation activities between 2016 and 2020 inclusive.
- b. an innovation is the introduction of a new or significantly improved product, process, organizational method, or marketing method by your enterprise. The innovation must be new to your enterprise, although it could have been originally developed by other enterprises.

The questions on innovation activities only refer to product and process innovations.

Please complete all questions, unless otherwise instructed.

Person we should contact if there are any queries regarding the form:

- c. name: .....
- d. job title: .....
- e. organization: .....
- f. phone: .....
- g. fax: .....
- h. e-mail: .....

## 1. General information about the enterprise

- Name of enterprise
- Address1
- Postal code

- 1.1. In 2016-20, was your enterprise part of an enterprise group? (A group consists of two or more legally defined enterprises under common ownership. Each enterprise in the group can serve different markets, as with national or regional subsidiaries, or serve different product markets. The head office is also part of an enterprise group.) Yes/No

In which country is the head office of your group located? .....HO

If your enterprise is part of an enterprise group: Please answer all further questions only for the enterprise for which you are responsible in [your country]. Exclude all subsidiaries or parent enterprises.

- 1.2. In which geographic markets did your enterprise sell goods and/or services during the three years 2016-19?

A. Local / regional within [your country]	Yes	No
B. National (other regions of [your country])	Yes	No
C. All other countries	Yes	No

## 2. Product (good or service) innovation

A product innovation is the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems.

- product innovations (new or improved) must be new to your enterprise, but they do not need to be new to your market
- product innovations could have been originally developed by your enterprise or by other enterprises

- 2.1. During the four years 2016 to 2020, did your enterprise introduce:

New or significantly improved goods. (Exclude the simple resale of new goods purchased from other enterprises and changes of a solely aesthetic nature.)	Yes	No
New or significantly improved services.	Yes	No

If no to both options, go to section 3, otherwise:

- 2.2. Who developed these product innovations?

Select the most appropriate option only

- mainly your enterprise or enterprise group
- mainly your enterprise together with other enterprises or institutions
- mainly other enterprises or institutions



2.3. Were any of your product innovations during the three years 2016 to 2020:

New to your market? Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets)	Yes	No
Only new to your firm? Your enterprise introduced a new or significantly improved good or service that was already available from your competitors in your market	Yes	No

2.4. Using the definitions above, please give the percentage of your total turnover in 2020 from:

- new or significantly improved goods and services introduced during 2016 to 2020 that were new to your market ..... %
- new or significantly improved goods and services introduced during 2016 to 2020 that were only new to your firm .....%
- goods and services that were unchanged or only marginally modified during 2016 to 2020 (include the resale of new goods or services purchased from other enterprises) ..... %
- total turnover in 2020 - ..... %

### 3. Process innovation

- a process innovation is the implementation of a new or significantly improved production process, distribution method, or support activity for your goods or services
- process innovations must be new to your enterprise, but they do not need to be new to your market
- the innovation could have been originally developed by your enterprise or by other enterprises
- exclude purely organizational innovations – these are covered in section 8

3.1. During the three years 2016 to 2020, did your enterprise introduce:

New or significantly improved methods of manufacturing or producing goods or services.	Yes	No
New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services	Yes	No
New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing.	Yes	No

If no to all options, go to section 4, otherwise:

3.2. Who developed these process innovations?

Select the most appropriate option only

- mainly your enterprise or enterprise group
- mainly your enterprise together with other enterprises or institutions
- mainly other enterprises or institutions

3.3. Were any of your process innovations introduced between 2016 to 2019 new to your market?

- yes
- no
- do not know

### 4. Ongoing or abandoned innovation activities for process and product innovations

Innovation activities include the acquisition of machinery, equipment, software, and licenses; engineering and development work, industrial design, training, marketing and R&D when they are specifically undertaken to develop and/or implement a product or process innovation. Also include basic R&D as an innovation activity even when not related to a product and/or process innovation.

4.1. During 2016 to 2020, did your enterprise have any innovation activities that did not result in a product or process innovation because the activities were:



Abandoned or suspended before completion	Yes	No
Still ongoing at the end of the 2020	Yes	No

If your enterprise had no product or process innovations or innovation activity during 2016 to 2020 (no to all options in questions 2.1, 3.1, and 4.1), go to section 8.  
Otherwise, go to section 5.

## 5. Innovation activities and expenditures for process and product innovations

5.1. During the three years 2016 to 2019, did your enterprise engage in the following innovation activities:

In-house R&D Creative work undertaken within your enterprise to increase the stock of knowledge for developing new and improved products and processes (include software development in-house that meets this requirement)	Yes	No
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If yes, did your enterprise perform R&D during 2016 to 2020: Continuously (your enterprise has permanent R&D staff in-house)

External R&D Same activities as above, but performed by other enterprises (including other enterprises or subsidiaries within your group) or by public or private research organizations and purchased by your enterprise	Yes	No
Acquisition of machinery, equipment and software-Acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products and processes	Yes	No

Acquisition of external knowledge

Purchase or licensing of patents and non-patented inventions, expertise, and other types of knowledge from other enterprises or organizations for the development of new or significantly improved products and processes	Yes	No
Training for innovative activities Internal or external training for your personnel specifically for the development and/or introduction of new or significantly improved products and processes	Yes	No
Market introduction of innovations-Activities for the market introduction of your new or significantly improved goods and services, including market research and launch advertising	Yes	No
Other activities to implement new or significantly improved products and processes such as feasibility studies, testing, routine software development, tooling up, industrial engineering, etc.	Yes	No

5.2. Please estimate the amount of expenditure for each of the following four innovation activities in 2020 only. (Include personnel and related costs)

If your enterprise had no expenditures in 2020, please fill in '0'

- in-house R&D (Include capital expenditures on buildings and equipment specifically for R&D) .....
- purchase of external R&D .....
- acquisition of machinery, equipment and software (Exclude expenditures on equipment for R&D) .....
- acquisition of external knowledge .....
- total of these four innovation expenditure categories .....

5.3. During the three years 2016 to 2020, did your enterprise receive any public financial support for innovation activities from the following levels of government? Include financial support via tax credits or deductions, grants, subsidized loans, and loan guarantees. Exclude research and other innovation activities conducted entirely for the public sector under contract.

Local or regional authorities	Yes	No
Central government	Yes	No
Any International body/ organization	Yes	No

## 6. Sources of information and co-operation for innovation activities

6.1. During the three years 2016 to 2020, how important to your enterprise's innovation activities were each of the following information sources? Please identify information sources that provided information for innovation projects or contributed to the completion of existing innovation projects. Degree of importance Tick 'not used' if no information was obtained from a source. Mark as - High/Medium/Low/ Not used

Internal Within your enterprise or enterprise group	High	Medium	Low	Not used
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### Market sources

Suppliers of equipment, materials, components, or software	High	Medium	Low	Not used
Clients or customers	High	Medium	Low	Not used
Competitors or other enterprises in your sector	High	Medium	Low	Not used
Consultants, commercial labs, or private	High	Medium	Low	Not used
R&D institutes	High	Medium	Low	Not used

### Institutional sources

Universities or other higher education institutions	High	Medium	Low	Not used
Government or public research institutes	High	Medium	Low	Not used

### Other sources

Conferences, trade fairs, exhibitions	High	Medium	Low	Not used
Scientific journals and trade/technical publications	High	Medium	Low	Not used
Professional and industry associations	High	Medium	Low	Not used

6.2. During the four years 2016 to 2020, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions? Innovation cooperation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to commercially benefit. Exclude pure contracting out of work with no active co-operation. Yes/No (Please go to question 7.1)

6.3. Please indicate the type of innovation co-operation partner by location (Tick all that apply)

Type of co-operation partner

- i. your country
- ii. any other countries

Other enterprises within your enterprise group	i	ii
Suppliers of equipment, materials, components, or software	i	ii
Clients or customers	i	ii
Competitors or other enterprises in your sector	i	ii
Consultants, commercial labs, or private R&D institutes	i	ii
Universities or other higher education institutions	i	ii
Government or public research institutes	i	ii

6.4. Which type of co-operation partner did you find the most valuable for your enterprise's innovation activities? Give corresponding mail/letter

7. Innovation objectives during 2016-2020

7.1. How important were each of the following objectives for your activities to develop product (good or service) or process innovations between 2016-2020?

If your enterprise had several projects for product and process innovations, make an overall evaluation on High/Medium/ Low/ Not used

Increase range of goods or services	High	Medium	Low	Not used
Replace outdated products or processes	High	Medium	Low	Not used
Enter new markets	High	Medium	Low	Not used
Increase market share	High	Medium	Low	Not used
Improve quality of goods or services	High	Medium	Low	Not used
Improve flexibility for producing goods or services	High	Medium	Low	Not used
Increase capacity for producing goods or services	High	Medium	Low	Not used
Improve health and safety	High	Medium	Low	Not used
Reduce labor costs per unit output	High	Medium	Low	Not used

8. Organizational innovation

An organizational innovation is a new organizational method in your enterprise's business practices (including knowledge management), workplace organization or external relations that has not been previously used by your enterprise.

- it must be the result of strategic decisions taken by management
- exclude mergers or acquisitions, even if for the first time

8.1. During the four years 2016-2020, did your enterprise introduce:

New business practices for organizing procedures (i.e., supply chain management, business re-engineering, knowledge management, lean production, quality management, etc.)	Yes	No
New methods of organizing work responsibilities and decision making (i.e., first use of a new system of employee responsibilities, teamwork, decentralization, integration or de-integration of departments, education/training systems, etc.)	Yes	No
New methods of organizing external relations with other firms or public institutions (i.e., first use of alliances, partnerships, outsourcing or subcontracting, etc.)	Yes	No

If no to all options, go to section 9

Otherwise, go to question 8.2

8.2. How important were each of the following objectives for your enterprise's organizational innovations introduced between 2016-2020 inclusive? If your enterprise introduced several organizational innovations, make an overall evaluation - High/Medium/ Low/ Not used

Reduce time to respond to customer or supplier needs	High	Medium	Low	Not used
Improve ability to develop new products or processes	High	Medium	Low	Not used
Improve quality of your goods or services	High	Medium	Low	Not used
Reduce costs per unit output	High	Medium	Low	Not used
Improve communication or information sharing within your enterprise or with other enterprises or institutions	High	Medium	Low	Not used

## 9. Marketing innovation

A marketing innovation is the implementation of an innovative marketing concept or strategy that differs significantly from your enterprise's existing marketing methods, and which has not been used before.

- it requires significant changes in product design or packaging, product placement, product promotion or pricing
- exclude seasonal, regular, and other routine changes in marketing methods

9.1. During the three years 2016-2020, did your enterprise introduce:

Significant changes to the aesthetic design or packaging of a good or service (exclude changes that alter the product's functional or user characteristics – these are product innovations)	Yes	No
New media or techniques for product promotion (i.e., the first time use of a new advertising media, a new brand image, introduction of loyalty cards, etc.)	Yes	No
New methods for product placement or sales channels (i.e., first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc.)	Yes	No
New methods for product placement or sales channels (i.e., first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc.)	Yes	No
New methods for product placement or sales channels (i.e., first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc.)	Yes	No

If no to all options, go to section 10.

Otherwise, go to question 9.2

9.2. How important were each of the following objectives for your enterprise's marketing innovations introduced between 2016-2020 inclusive?

If your enterprise introduced several marketing innovations, make an overall evaluation - High/Medium/Low/ Not used

Increase or maintain market share	High	Medium	Low	Not used
Introduce products to new customer groups	High	Medium	Low	Not used
Introduce products to new geographic markets	High	Medium	Low	Not used

## 10. Innovations with environmental benefits

An environmental innovation is a new or significantly improved product (good or service), process, organizational method or marketing method that creates environmental benefits compared to alternatives.

- the environmental benefits can be the primary objective of the innovation or the result of other innovation objectives
- the environmental benefits of an innovation can occur during the production of a good or service, or during the after sales use of a good or service by the end user.

10.1. During the three years 2016-2020, did your enterprise introduce a product (good or service), process, organizational or marketing innovation with any of the following environmental benefits?

Environmental benefits from the production of goods or services within your enterprise

Reduced material uses per unit of output	Yes	No
Reduced energy use per unit of output	Yes	No
Reduced CO2 'footprint' (total CO2 production) by your enterprise	Yes	No
Replaced materials with less polluting or hazardous substitutes	Yes	No
Reduced soil, water, noise, or air pollution	Yes	No
Recycled waste, water, or materials	Yes	No

Environmental benefits from the after sales use of a good or service by the end user

Reduced energy uses	Yes	No
Reduced air, water, soil, or noise pollution	Yes	No
Improved recycling of product after use	Yes	No

10.2. During 2016-19, did your enterprise introduce an environmental innovation in response to:

Existing environmental regulations or taxes on pollution	Yes	No
Environmental regulations or taxes that you expected to be introduced in the future	Yes	No
Availability of government grants, subsidies, or other financial incentives for environmental innovation	Yes	No
Current or expected market demand from your customers for environmental innovations	Yes	No
Voluntary codes or agreements for environmental good practice within your sector	Yes	No

10.3. Does your enterprise have procedures in place to regularly identify and reduce your enterprise's environmental impacts? (For example, preparing environmental audits, setting environmental performance goals, ISO 14001 certification, etc.).

Yes: implemented before 2016

Yes: Implemented or significantly improved after 2016

No

11. Basic economic information on your enterprise

11.1. What was your enterprise's total turnover for 2016-2020?

Turnover is defined as the market sales of goods and services (Include all taxes except VAT).

- 2016-17 .....
- 2017-18 .....
- 2018-19 .....
- 2019-20.....

11.2. What was your enterprise's total number of employees in 2016-19?

- 2016-17 .....
- 2017-18 .....
- 2018-19 .....
- 2019-20.....

Part of the questionnaire is adopted and modified from-The Community Innovation Survey 2008 (CIS2008)[https://ec.europa.eu/eurostat/documents/203647/203701/CIS\\_Survey\\_form\\_2008.pdf/e06a4c11-7535-4003-8e00-143228e1b308](https://ec.europa.eu/eurostat/documents/203647/203701/CIS_Survey_form_2008.pdf/e06a4c11-7535-4003-8e00-143228e1b308). It was shared with 250 executive in various roles (General Manager, and Above level only) in the Indian Food Processing SMEs. Out of this complete information was received from only 88 SMEs. First and foremost, the objectives which Indian Food Processing SMEs have for performing innovation is analyzed with the help of data collected through the survey conducted {attached annexure 1}. Mentioned below in table 3.1 reflects the nine objectives of doing innovation and each SME was asked to rank these objectives on a scale of 0-3 (Rating used for the same: 0-Not relevant, 1-Low, 2-Medium, and 3-High) as per the

importance of these objectives experienced by the SMEs while innovating. Mean is obtained by taking the average of innovation objectives by Indian Food Processing SMEs.

Table 8. Objectives of innovation in Indian Food Processing SMEs.

Objectives of Innovation	Mean of Indian Food Processing SMEs s (n=88)
Upgrading goods or services- in terms of quality	1.568
Expanding goods or services- in terms of variety	1.568
Growing market share	1.648
Penetrating in new markets for goods or services	1.386
Minimizing labor costs per unit output	1.602
Enhancing elasticity for manufacturing goods or services	1.216
Displacement of obsolete products or processes	1.864
Escalating volume for manufacturing goods or services	1.500
To boost well-being, safety, and protection of customers	1.761

The above table 3.b.1 throws light on the outcome for the nine objectives of the Indian Food Processing SMEs actively performing innovation and the mean value written against each objective reflects their significance and substance that these objectives hold for the Indian Food Processing SMEs under this study. Altogether, 88 Indian Food Processing SMEs responded to the survey which are actively involved in innovation and treats to boost well-being, safety, and protection of customers as their main objective for performing innovation especially in the form of product innovation during COVID times followed by displacement of obsolete products or processes as their second main objective, which is followed by growing market share and minimizing labor costs per unit output were the third and the fourth most important innovation objectives. And the fifth most important objective position is grabbed by upgrading goods or services- in terms of quality and expanding goods or services- in terms of variety particularly after the downfall faced by the SMEs as the aftereffects of COVID 19 Pandemic [13,14].

### Methods, results, and discussion

The survey conducted throws light on the activities related to innovation in Indian Food Processing SMEs. Survey classified the activities into- involvement in inside R&D, involvement in outside R&D, buying /taking license for outside knowledge, product innovation and process innovation. The results indicate that of the 88 innovative Indian Food Processing SMEs, 81.8% SMEs involved in inside R&D activities, while 39.8% involved in outside R&D and 30.7% SMEs bought/took license for outside knowledge. Out of these 88 SMEs, 69.3% SMEs did perform product innovation in the 4 years, while 58% did perform process innovation. In a nutshell, the outcome of the survey suggested that Indian Food Processing SMEs are initiative-taking in involving themselves in inside R&D in comparison to the outside R&D and buying or taking license for outside knowledge. Other than these activities, product innovation was performed more in comparison to process innovation by the Indian Food Processing SMEs [13,14].

Table 9. Activities related to Innovation.

Indian Food Processing SMEs	Involvement in Inside R&D (%)	Involvement in outside R&D (%)	Buying /taking license for outside Knowledge (%)	Product Innovation (%)	Process Innovation (%)
N=88	81.8%	39.8%	30.7%	69.3%	58%

### Collaboration with outside parties

For understanding the collaboration done by Indian Food Processing SMEs with outside parties- following outside parties which were used by the SMEs as their source of information and knowledge were studied-sister concerns of the SMEs, components or machinery suppliers, customers, rivals in the same industry, private consultants, R&D labs, Higher education institutions or universities, government offices, Exhibitions, Trade Fairs, Conferences, Publications, Journals and Professional Association bodies.

Table 10 throws light on the involvement of Indian Food Processing SMEs with the above mentioned outside parties in India.

Table 10. Collaboration with outside parties.

Collaboration with outside parties	1. Sister concerns of SMEs	2. Suppliers of equipment, machinery	3. Customers	4. Rivals	5. Private Consultants	6. R & D Institutions	7. Higher education institutions or universities	8. Government offices	9. Exhibitions, Trade Fairs, Conferences	10. Publications, Journals	11. Professional Association bodies	No collaboration % of SMEs	Collaboration with 1-5 outside parties -% of SMEs	Collaboration with 6-11 outside parties -% of SMEs
Indian Food Processing SMEs (n=88)	77.3%	77.3%	86.4%	62.5%	65.9%	68.2%	53.4%	62.5%	59.1%	13.6%	59.1%	0%	31%	69%

The collaboration with outside parties was calculated with a range from 0-11, with 0 when no outside parties were used for collaboration, in comparison those Indian Food Processing SMEs got the score of 11 which collaborated with all outside parties. Collaboration was then asked by the informants to be grouped as low or high, SMEs which collaborated with 1-5 outside parties had low collaboration, on the other hand SMEs engaged 6-11 outside parties were assumed to have high collaboration.

Table 4.2 clearly reflects the collaboration range that 0% SMEs (n=88) did not collaborate with outside parties, 31% collaborate with 1-5 outside parties while 69% collaborate with 6-11 outside parties. In case Indian Food Processing SMEs are collaborating, the main collaborators (n=88) are their suppliers of equipment & machinery, and clients with 77.3% and 86.4% respectively. In contrast, Publications & Journals or Higher education institutions or universities are the least preferred collaboration parties for innovation as per the Indian Food Processing SMEs under this study.

#### Extent of openness in the innovation process of Indian Food Processing SMEs.

To further throw light on the activities related to innovation and the collaborations taking place with outside parties Table 4.3 reflects the Indian Food Processing SMEs position on average product innovation output {which is average of the sum of turnover from new to market products & turnover of new to firm's products doing product innovation} and the average extent of openness {which is the average taken of the external interactions SMEs engage in which is calculated in table 4.2} in the innovation process. The analysis reflects that in the Indian Food Processing SMEs the average product innovation output of SMEs in India under this study is 15 (n=88) and the average extent of openness in the innovation process of these Indian Food Processing SMEs (n=88) when collaborating with outside parties for their process of innovation is 4 out of 7\*.



Table 11. Innovation output and openness.

Extent of Openness	Number of Firms	Average of Product Innovation Output	Extent of openness in the Innovation Process
Indian Food Processing SMEs	88	15	4 out of 7*

\* As no SME in Indian food processing industry under this study went for collaboration with any foreign firm:1.

Other enterprises within your enterprise group, 2. Suppliers of equipment, materials, components, or software, 3. Clients or customers, 4. Competitors or other enterprises in your sector, 5. Consultants, commercial labs, or private R&D institutes, 6. Universities or other higher education institutions, 7. Government or public research institutes.

#### Indian Food Processing SMEs product innovation output and Open Innovation

Multiple regression analysis was used to find out how ably prediction can be done regarding the product innovation output of Indian Food Processing SMEs by evaluating the collaborations done and the expenditure done on innovations. As per Drechsler and Natter 2012 [15], variables that suggested openness in the process of innovation were divided into two parts - (i) dependent variable i.e., product innovation output and (ii) independent variables were expenditure done by internal R&D team, buying R&D information or knowledge from outside parties, taking license for outside R&D, and the scope or extent of openness in the innovation process. Also, the control variables of the survey were- Size of the firm (to be SME as per the new definition given by the government in June 2020) and industry (to be Indian Food Processing) [16].

#### Variables- Dependent and Independent

Dependent variable – Under this study, product innovation output is the dependent variable which is measured to check the innovation performance of Indian Food Processing SMEs. This variable can reflect the capacity of the SMEs to perform innovation. The product innovation output under this study is calculated by taking the average of the sum of incomes in the last five years (2015 to 2020 year) from new to market products and incomes in the last five years (2015 to 2020 year) for SMEs performing product innovation from new to firm products.

Independent variable – Under this study the following variables were included (i)expenditure done by internal R&D team, (ii) buying R&D information or knowledge from outside parties, (iii) taking license for outside R&D (iv) scope or extent of openness in the innovation process. And these variables are continuous in nature. The variable reflecting the scope or openness in the innovation process concerning the collaboration with outside parties was calculated with the help of Drechsler and Natter (2012) formula - adapted and modified:

$$(1) \quad SO_i = SKC_{ji} + \sum_{j=1}^7 DCT_{ji} + \sum_{j=1}^7 FCT_{ji}$$

Where-Under this study extent or scope of openness is calculated in the following manner:

$SO_i$ = Scope/ extent of openness of SME i

$SKC_{ji}$ = Significance of knowledge obtained from collaboration which includes buying or taking outside knowledge j, as perceived by SME i {calculated in table 4.2}

$DCT_{ji}^*$  =Domestic collaboration type j used by firm i

$FCT_{ji}^*$  =Foreign collaboration type j used by firm i

\*{conversion in binary “0” for no collaboration and “7” for all parties’ involvement} Together for Domestic +Foreign =Range from 0 to 14. “0” means No adoption of Open Innovation and “14” means High degree of Open Innovation.

Control Variables=Firm size {“0” score less than 50 employees and “1” score if equals to or more than 50 employees}

j= sister concerns of the SMEs; components or machinery suppliers; customers; rivals in the same industry; private consultants; R&D labs; Higher education institutions or universities; government offices.

Involvement in outside collaboration was taken as a continuous variable under this study, whereby 0 was given when SMEs do not use buying or take license for using outside information and knowledge and 1 was given by the informants when used. And for calculating domestic collaborations with outside parties, 0 was given when no domestic collaboration was done and 1 was given by the informants when used for each outside party and this ranged between 0 - 7 and the SMEs got 7 when collaborating with all potential collaborating parties. Similarly, for foreign collaboration score ranged from 0 - 7, but under this study it was 0 for all SMEs. On the grounds of the above analysis, range of 0 - 14 was utilized to give scores for the scope/ extent of openness in the Indian Food Processing SMEs, whereby SMEs could get 0 for not adopting any activity reflecting open innovation, on the other hand SMEs with 14 score are assumed to highest scope/ extent of openness in their innovation process. Under the study, SMEs size and Food Processing Industry was used as the control variable. In the survey conducted the SME size was calculated keeping in mind the number of employees it had and was coded in binary form whereby 0 was used for SMEs having less than 50 employees and 1 was used for SMEs having more than or equals to 50 employees.

### Statistical analysis and results

Multiple regression analysis was used to find out how ably prediction can be done regarding the product innovation output of Indian Food Processing SMEs by evaluating the collaborations done and the expenditure done on innovations. Under this study (i) dependent variable i.e., product innovation output and (ii) independent variables were expenditure done by internal R&D team, buying R&D information or knowledge from outside parties, taking license for outside R&D, and the scope or extent of openness in the innovation process. Also, the control variables of the survey were - Size of the firm (to be SME as per the new definition given by the government in June 2020) and industry (to be Food Processing). On scrutinizing the data collected through the survey it was found that out of all the respondents 89 SMEs in Indian Food Processing SMEs gave complete response required for regression analysis and therefore, regression was performed only on these SMEs. Below in table 5.1 below reflects the summary of the regression model and its result. The independent variables account for 59% of the product innovation output variance ( $R^2 = 0.59$ ).

Table 12. Regression model analysis and result of Indian Food Processing SMEs [13,14].

Independent Variables	Dependent Variable		Mean	Standard Deviation
	Coefficient	p-value		
Extent of Openness	0.009	1.462	0.147	0.056
In-house R&D expenditure	0.055	0.858	0.748	0.084
Purchase of External R&D	0.021	0.617	0.502	0.063
Acquisition of External	0.032	0.796	0.428	0.071
Firm Size	0.015	0.140	0.889	0.034

Out of the independent variables of this study, following variables found to have less impact on the product innovation output in Indian Food Processing SMEs- (i) expenditure done by internal R&D team, (ii) taking license for outside R&D, and (iii) the size of the SME in terms of its employees. In contrast to this, (i) buying R&D information or knowledge from outside parties and (ii) and the scope or extent of openness in the innovation process have observed to have a powerful impact on the product innovation output. No doubt, it can be concluded that the scope/ extent of openness in the innovation process of Indian Food Processing SMEs had crucial, constructive, and positive impact on the product innovation output. Further it proposes that SMEs with higher extent of openness in their innovation process tend to have high level of Product innovation output.

### **Impact**

The research done is highlighting the innovation taking place in Indian Food Processing SMEs with a special focus on open Innovation taking place in these SMEs and the exchange of information or knowledge taking place between inside - out and outside - in parties for the purpose of innovation. In addition, puts special focus on describing how SMEs' product innovation output related with the effect of outside-in and inside-out exchange of knowledge and information. Further, it analyzes how expenditure on innovation and collaborating with outside parties can help in the predicting product innovation output of Indian Food Processing SMEs. The analysis was done with the help of Jamovi to find out regression between the dependent variable - "Product innovation

output” & independent variables- “Extent of openness”, “Inhouse R& D expenditure”, “Purchase of R&D from outside sources”, “Acquiring knowledge from outside sources” and control variable - “Indian Food Processing SMEs”. And towards the end, it contains the summary of the survey done, which suggested that Indian Food Processing SMEs are proactively involved themselves in inside R&D in comparison to the outside R&D and buying or taking license from outside sources. Other than these activities, one more pointer came as a takeaway from the study, product innovation is performed more in comparison to process innovation by the Indian Food Processing SMEs.

Thus, it is imperative that Indian policymakers propose and implement policies that provide support/assistance to Indian food processing SMEs owned by women through training and skill development to help them succeed in the face of the COVID - 19 pandemic. The proposed suggestions may be useful in future academic studies and will help businesses solve difficult decision-making problems, allowing them to move closer to the Sustainable Development Goals of Goal 9 (Industry, Innovation, and Infrastructure), Goal 1 (No Poverty), and Goal 12 (Ensure a Sustainable Consumption and Production Pattern), especially now that COVID-19 is having such a negative impact on the Indian economy. In practical terms, the study includes interpretations and discussions that will help policymakers and related associations formulate and develop policies and procedures to empower Indian food processing SMEs to initiate Open innovation in their businesses in an effective manner and increase their product output.

### Conclusions

To encapsulate the analysis of the data collected through the survey of the Indian Food Processing SMEs gives the following findings:

- SMEs in Indian Food Processing sector treat following as their main objectives- To boost well-being, safety, and protection of customers, growing their market share and upgrading goods or services - in terms of quality
- In - house R&D is preferred by most of the SMEs in comparison to the outside R&D or buying or taking license for the outside information/ knowledge.
- the most usual form of innovation in the Indian Food Processing SMEs is the Product innovation.
- SMEs and large go for collaboration with 4 on a range of 7 outside parties for innovation. Customers followed by suppliers are the most frequently collaborated parties for innovation whereas Publications & Journals or Higher education institutions or universities are the least favored ones.
- SMEs with higher extent of openness in their innovation process tend to have high level of Product innovation output.

To summarize, the survey data collected and analyzed with regression model presents the sketch of the Indian Food Processing SMEs and their innovation and open innovation activities. In depth this study reports the scope/ extent of openness in the innovation process of the Indian Food Processing SMEs and further throws light, on its influence on the product innovation output. The inferences of the above stated findings are studied in chapter-7 of this study. The data so collected under this study, emphasize on innovation and open innovation taking place in Indian Food Processing SMEs.

### Conflict of interest

There are no conflicts to declare.

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