Application of ISM Methodology to Study the Hierarchical Inter-relationships amongst Various Challenges Faced by the Bakery Industry in India

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ABSTRACT
Given the hectic and fast-paced urban as well as rural life in India and the introduction of added gluten free alternatives, bakery industry in India has a bright future. But this industry is not new to the stream of various constraints and barriers. In view of the current popularity of the research area, present research work first explores the various challenges faced by the bakery industry in India and thereafter, it studies the interrelationships amongst them using ISM methodology. The research is primarily exploratory in nature with a stint on the use of qualitative mathematical decision- making methodology namely ISM, for studying the possible hierarchical inter-relationships amongst them.

Keywords
Bakery industry; ISM methodology; Hierarchical inter-relationships

1. INTRODUCTION
The Bakery Industry in India reached a value of **US $7.22 Billion in 2018** and further, the market value is projected to exceed **US $12 Billion by 2024.** This industry experiences a robust growth of over 9 percent and it is a huge industry which is employing a quantum of people. The industry is a full flourished sector with over a million an organised small-scale bakery and more than 2000 organised or semi organised bakeries. The Bakery sector is the largest of all the segment of India's food processing sector. A large part of this market nearly 80% is captured by Fast moving Consumer goods items such as breads and biscuits which are consumed on daily basis.

The growth of an industry also brings its own challenges and the most important of them being increasing sufficient capacity to meet the new age demands. Customers expect freshness, choice and quality. Therefore, in these highly competitive retailers - together with suppliers - are constantly looking for innovative products to create a head start.

The research paper is arranged as follows: Section 2 describes the challenges Indian bakeries are facing . Section 3 describes the ISM methodology and section 4 presents the case example. Conclusions are presented in section 5.

2. CHALLENGES FACED BY INDIAN BAKERIES
Some of the common challenges are :

2.1 Adherence to food safety and compliances [AFSC] : Food Safety and compliance has become a major factor in the industry. Mandatory quality checks are a requirement of wash-down procedures, finished product reviews and formulation temperatures. Quality control's emphasizes controllable factors (such as track and tracing), that affect the quality of the finished product.

2.2 Planning for long term [PLT]: To get bulk advantages form their supplies, there is a requirement to plan ahead. This makes the raw material availability to be strict. In this process, the availability of raw materials is strict so therefore the production planning and the purchasing planning side need to have real-time and correct data on their stock inventory else their production will eventually stop.

2.3 Maintaining an effective production processes [EPP]: Production processes need to be as effective as possible, with real-time data and track & trace information. Without an ERP, organizations don't have the real-time insights into how long the production order is and the availability to have real-time labor and machine costs.

2.4 Reduce your scrap percentages [RSP]: Production machines have a specific capacity. An oven has a specific amount of space available and in order to have the most efficient usage, companies need to be able to plan on that bottleneck. Calculating these times needs to be done ahead to reduce scrap percentages.

2.5 Daily prognoses [DP]: In the bread and bakery industry, production based on daily prognoses is common. Fresh food must be delivered every day, but every day is different. You therefore want to start producing your products early, after which the orders arriving throughout the day and the production numbers are adjusted.

2.6 Re-use co- and by-products [Re-use]: Food processing companies need a plan on reusing rework materials for future batches, which results in removing the risk of food contamination and overall improved manufacturing processes. Strict health coding implies that you are not allowed to use different batches/lots in one and the same production order that will become 1 end product batch.

2.7 The packaging value [PV]: Many production organizations still work with Excel files for their outgoing/ returning packaging which doesn't give the right insight into the value of the packaging. If the packaging stock is incorrect than that leads to the value of the financial balance also being **incorrect, which will also imply risks on a financial level.**

2.8 Staffing Weaknesses of a Bakery [SWB] [Brian Hill, 2019] : Bakery products are perishable so there's a risk that you'll have a lot of wastage if your products do not sell, and staffing may present an ongoing problem. The problems faced by bakeries are possible to resolve in many places. When they are, the margins and profits are potentially high.

2.9 Challenge of Operations and Cleanliness [O/C]: Poorly operated bakeries waste ingredients and labor, increasing expenses and lowering profit margins. Inadequate equipment results in the waste of cakes and breads not properly baked. Train employees to keep the bakery sparkling at all times. Spot-check refrigerator and freezer temperatures to make sure they are within allowable variances. Know what the health codes are and enforce them.

2.10 Bakery Marketing Challenges [BMC]: A non- existent marketing plan is a weakness of a bakery. Use social media to develop a list of friends, groups and followers. Announce specials, new breads and recipes through the social media sites as well as on your bakery's blog or website. Create contests to name a new muffin or bagel, awarding the winner a week's free supply.

2.11 Divided industry and lack of skilled workers [DI &LSW]: The industry is generally divided into organized and unorganized, with more than 2,000 organized or semi-organized bakeries, and 1,000,000 unorganized bakeries. Operational efficiency is a major issue in the industry, as is the lack of technology and skilled workers.

2.12 Hygiene [Hy]: Making facilities hygienic also requires that there should be adequate number of toilets, hand-washing facilities and changing rooms for the workers. As per FSSAI, it is required that the facilities to have sufficient number and separate hygienically designed toilets with proper flushing facilities for male and female employees.

2.13 Increase in demand for fortified items [DFI]: As per FSSAI, these include fibre, antioxidants, omega-3 oils, and vitamin and mineral fortifications also pose new challenges for the industry. Such modifications can be challenging to bakers as changes in formulation may result in the need for changes to equipment, processes and ingredient costs," states the FSSAI document.

2.14 Lack of innovation [LOI]: This is another big challenge for industry in view of increasing competition in the market. There is also need to increase awareness about the digital technologies and convenience of social media platforms that can help bakeries in the unorganised sector reach a wider market.

3. ISM METHODOLOGY

Interpretive Structural Modelling (ISM) is an interactive learning process in which a set of unique, interrelated variables are structured into a comprehensive model presented as a hierarchy graph. The method is interpretive in that the group's judgement decide whether and how items are related. The steps involved in ISM includes Identification of elements which are relevant to the decision maker's problems and issues. Thereafter , establishing the contextual relationship between elements with respect to which pairs of elements will be examine. Developing a self-interaction matrix (SSIM) which involves establishing pairwise relationship between two variables i.e. i and j. based on four symbols viz. V , A X and O for the type of relation that exists between two sub-variables under consideration. Using SSIM matrix, initial reachability matrix can be formed, it has all values in binary form. Decision maker must check for rule of transitivity. From the reachability matrix, the reachability set and antecedent set for each criterion is found (Warfield (1974)). Then the intersection of these sets is derived for all elements. The element for which the reachability and intersection sets are the same is the top-level element. The whole process of partitioning is based on establishing the precedence relationships and arranging the elements in a topological order. Factors are classified in various categories like autonomous, dependent, driver and linkage. Finally , development of Diagraph/ ISM from the canonical matrix form.

4. CASE Example

Sixteen challenges viz. **Challenge of strict adherence to food safety and compliances [AFSC] ; Challenge of planning for long term [CPLT]; Challenge of m**aintaining an effective production processes [EPP]; Challenge to reduce your scrap percentages [RSP]; **Daily prognoses [DP] ;** Re-use co- and by-products [Re-use]; Improving **packaging value [IPV] ; challenge of weak staff** of a Bakery [SWB]; Operations and Cleanliness issue [O/C] ; Bakery Marketing Challenges [BMC]; Rising price of ingredients and price sensitivity [RPI] ; Hygiene [Hy] ; The increase in demand for fortified items [DFI]: Requirement for Innovating new products [INP]; Division of industry [LOI].

4.1 Structural Self – Interaction Matrix [SSIM]

Fig 1: SSIM matrix for pair wise relationship amongst barriers

S. No.	Barriers	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		AFSC	CPLT	EPP	RSP	DP	Re-Use	IPV	SWB	O/C	BMC	DI	Hy	DFI	LOI
1	AFSC		A	A	V	V	V	V	A	X	X	V	V	V	V
2	CPLT			V	V	V	V	V	V	V	V	V	V	V	V
3	EPP				V	V	V	V	V	V	V	V	V	V	V
4	RSP					A	A	X	A	V	A	A	A	A	A
5	DP						V	V	V	V	V	V	V	V	X
6	Re-Use							A	A	A	A	A	A	A	A
7	IPV								A	V	V	V	V	V	X
8	SWB									V	V	V	V	V	V
9	O/C										V	V	V	V	X
10	BMC											A	A	A	A
11	DI												A	A	A

12	Hy													V	V
14	DFI														V
16	LOI														

4.2 Initial reachability matrix

Fig 2: IRM for pair wise relationship amongst barriers

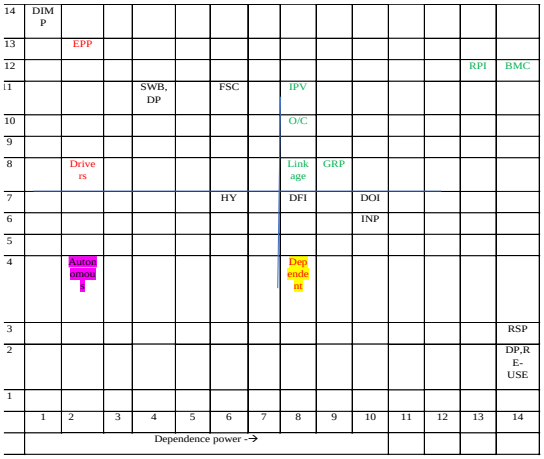
S. No.	Barriers	1	2	3	4	5	6	7	8	9	10	11	12	14	16
		FSC	DIMP	EPP	RSP	DP	Re-Use	IPV	SWB	O/C	BMC	RPI	Hy	DFI	LOI
1	FSC	1	0	0	1	1	1	1	0	1	1	1	1	1	1
2	DIMP	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	EPP	1	0	1	1	1	1	1	1	1	1	1	1	1	1
4	RSP	0	0	0	1	0	0	1	0	1	0	0	0	0	0
5	DP	0	0	0	1	1	1	1	1	1	1	1	1	1	1
6	Re-Use	0	0	0	1	0	1	0	0	0	0	0	0	0	0
7	IPV	0	0	0	1	0	1	1	0	1	1	1	1	1	1
8	SWB	1	0	0	1	0	1	1	1	1	1	1	1	1	1
9	O/C	1	0	0	1	0	1	1	0	1	1	1	1	1	1
10	BMC	1	0	0	1	0	1	0	0	0	1	0	0	0	0
11	RPI	0	00	0	1	00	1	0	0	0	1	1	0	0	0
12	Hy	0	0	00	1	0	1	0	00	0	1	1	1	1	1
14	DFI	0	0	0	1	0	1	00	0	0	1	1	0	1	1
16	LOI	0	0	0	1	0	1	1	0	0	1	1	0	0	1

4.3 Final reachability matrix

Fig 3: FRM for pair wise relationship amongst barriers

S. No.	Barriers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
		FSC	DIMP	EPP	RSP	DP	Re-Use	IPV	SWB	O/C	BMC	RPI	Hy	DFI	LOI	D.P
1	FSC	1	0	0	1	1	1	1	0	1	1	1	1	1	1	11
2	DIMP	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
3	EPP	1	0	1	1	1	1	1	1	1	1	1	1	1	1	13
4	RSP	0	0	0	1	0	1	1	0	1	0	0	0	0	0	4
5	DP	0	0	0	1	1	1	1	1	1	1	1	1	1	1	11
6	Re-Use	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2
7	IPV	0	0	0	1	0	1	1	0	1	1	1	1	1	1	9
8	SWB	1	0	0	1	0	1	1	1	1	1	1	1	1	1	11
9	O/C	1	0	0	1	0	1	1	0	1	1	1	1	1	1	9
10	BMC	1	0	0	1	0	1	0	0	0	1	0	0	0	0	4
11	RPI	0	00	0	1	00	1	0	0	0	1	1	0	0	0	4
12	Hy	0	0	00	1	0	1	0	00	0	1	1	1	1	1	7
13	DFI	0	0	0	1	0	1	00	0	0	1	1	0	1	1	6
14	LOI	0	0	0	1	0	1	1	0	1	1	1	0	0	1	6
	De.P	6	1	2	14	4	14	9	4	8	12	11	8	9	10	

4.4 Driving power and dominance diagram



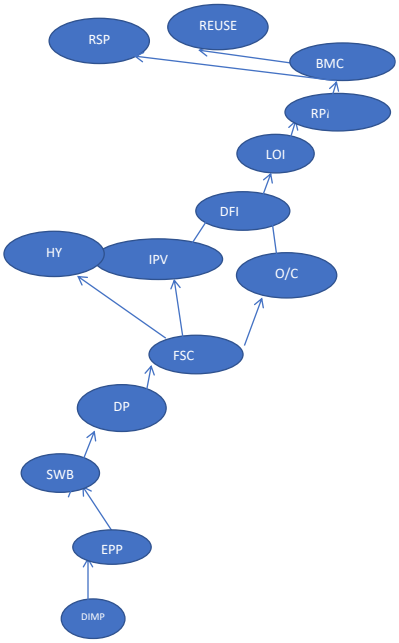
4.3 Level Partition

From the final reachability matrix, reachability and final antecedent set for each factor are found. The elements for which the reachability and intersection sets are same are the top-level element in the ISM hierarchy. After the identification of top- level element, it is separated out from the other elements and the process continues for next level of elements. Reachability set, antecedent set, intersection set along with different level for elements have been shown below in table 4.3.1.

Table 4.3.1: Iteration I

Reachability set	Antecedent set	Intersection set	Iteration	Factor/s selected at the iteration
4,6	1,2,3,4,5,6,7,8,9,10,11,12,13,14	4,6	I	**4,6**
4,6,10	1,2,3,5,7,8,9,10,11,12,13,14	10	II	**10**
4,6,10,11	1,2,3,5,7,8,9,11,12,13,14	11	III	**11**
4,6,10,11,14	1,2,3,5,7,8,9,12,13,14	14	IV	**14**
4,6,10,11,13,14	1,2,3,5,7,8,9,12,13	13	V	**13**
4,6,10,7,9,11,12,13,14	1,2,3,5,7,8,9,12,13	7, 9 , 12	VI	**7,9,12**
1,4,6,10,7,9,11,12,13,14	1,2,3,5,8,9	1	VII	**1**
1,4,5,6,10,7,9,11,12,13,14	1,2,3,5,8	1,5	VIII	**5**
1,4,5,6,10,7,8,9,11,12,13,14	2,3,5,8	8	IX	**8**
1,3,4,5,6,10,7,8,9,11,12,13,14	2,3	3	X	**3**
1,2,3,4,5,6,10,7,8,9,11,12,13,14	2	2	XI	**2**

4.5 ISM DIAGRAPH



5. CONCLUSIONS

Present research work first explores the various challenges faced by the bakery industry in India and thereafter, it studies the interrelationships amongst them using ISM methodology. The research is primarily exploratory in nature with a stint on the use of qualitative mathematical decision- making methodology namely ISM, for studying the possible hierarchical inter-relationships amongst them.

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