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Brief review of food industry R&D

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Abstract

The food industry includes a complex network of activities related to the supply, consumption and preparation of food and food services. This is one of the most dynamic economic sectors in the world. A R&D unit is needed to keep the food factory dynamic. Research and development using innovation can always be dynamic and agile. The most important activity in the food industry research and development unit is create new products. This article discusses the goals and structure of the R&D unit and proposes a way to make decisions in this unit. Also, how to select the effective manpower in this unit based on the Belbin test is presented. Finally, a process to introduce a new product to the market is proposed.

Keywords: R&D, Sturctre, Innovation, Belbin method, Project, NPD.

Introduction

The food industry comprises a complex network of activities related to the supply, consumption, and catering of food products and services. It is one of the world's most dynamic economic sectors.[1]Research and (technical or technological) development plays a vital role in ensuring a brand's success. Both help a company to stay ahead of competitors as well as increase the chances of leading the future. Businesses should have a Research and Development group to oversee the production of new products or for discovering and creating new knowledge related to technological and scientific topics.It all depends on what a brand wants to do. Such a unit is responsible for brainstorming innovation, creation, and more.[2,3]

The food industry faces several challenges. Various areas of the industry have been criticized and the food industry works hard to discredit its critics. [1] R&D is an integral component of any food industry strategic business plan; both are vital to a firm's long-run survival and growth.[2,4] This paper provides a brief activity in food industry R&D.

Definition and Aim

At first, there are two main question "What is R&D?" and "why R&D is important?" Twiss in 1992 R&D is defined "R&D is the purposeful and systematic use of scientific knowledge to improve man's lot even though some of its manifestations do not meet with universal approval." And Roussel et al in 1991 "To develop new knowledge and apply scientific or engineering knowledge to connect the knowledge in one field to that in others." [2]Research on any aspect of food industry produces relevant information about that sector. The food serving sector has the largest potential of research and development. Research reflections may be on factors influencing

consumer behavior, customers' buying choices, formation of attitude, and opinions. Companies need to have a deep understanding of how consumers behave. [1] Professor Hassan A. Al-Kahtani in 2015 the importance of R&D is described as follow: [2]

- Crucial to survival
- Fast changing environment
- Continuous technology change
- Competition
- Changing consumer preferences
- Fundamental to "marketing"
- Advantage is markets come from:

a. Understanding what markets need (MR)
b. In case of technology
c. selling what is possible to make
d. Efficient production processes

The basic aim of food industry research and development (R&D) is to create new products and launch them successfully on the market. Some specific aims of strategic R&D are to: reduce costs which lower product prices; enhance sensory properties that make food more attractive; improve nutritional value to provide for dietary needs; improve food safety; add convenience; and offer greater choices of food items to consumers. These benefits come either from constant gradual product improvement or a significant product step change. The latter usually comes from new technology-crop, ingredient, process, storage-but it can also come from a new understanding of consumer needs. [4]

The food industry is traditionally conservative industry, therefore their R&D acts rather traditionally as well and can be described as having a conservative and a rather careful approach to R&D of new products and processes. The processing and manufacturing sections of the food industry include a few large multinationals and many small companies. While the ultimate aim of all of their R&D is the same, their knowledge and resource bases are very different. Small companies usually concentrate their R&D where they have strong specialist knowledge. A large company needs research in many areas and is faced with the problems of integrating the research and coordinating it with the company's operating sections. Both sized companies aim at effective product development and successful launching of new products. [3,4] was suggested and analyzed based on personal observation that the smaller the company and its R&D group the bigger the drive toward innovative solutions, while larger groups typically focus more on renovation of their product and process portfolio. [2,3]

R&D Structure

A firm's R&D organizational structure can also affect the ways in which its researchers undertake a technological search. [5] The organization of research within these large firms typically takes on one of three structures. Examples are shown in Figures 1, 2, and 3. In the centralized structure, there is a single executive in charge of the firm's research activities who reports directly to a corporate-level executive such as the CEO or President. In the decentralized structure, research is conducted exclusively within divisions or business units, and R&D directors report to division general managers. In the hybrid structure, research is conducted both within a centralized function whose leader reports to corporate management, and within the firm's divisions or business units. An R&D director at the divisional level reports to his/her division general manager, who in turn reports to corporate management. [6]

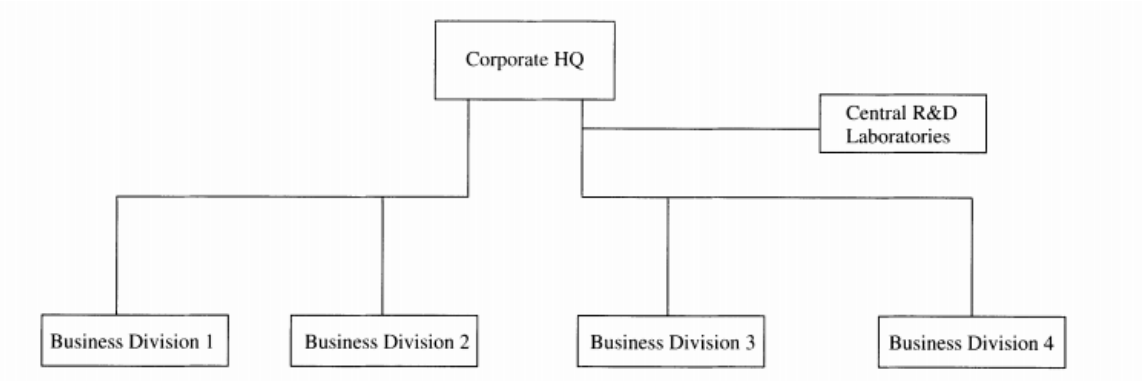

Figure1. Centralized R&D structure. [6]

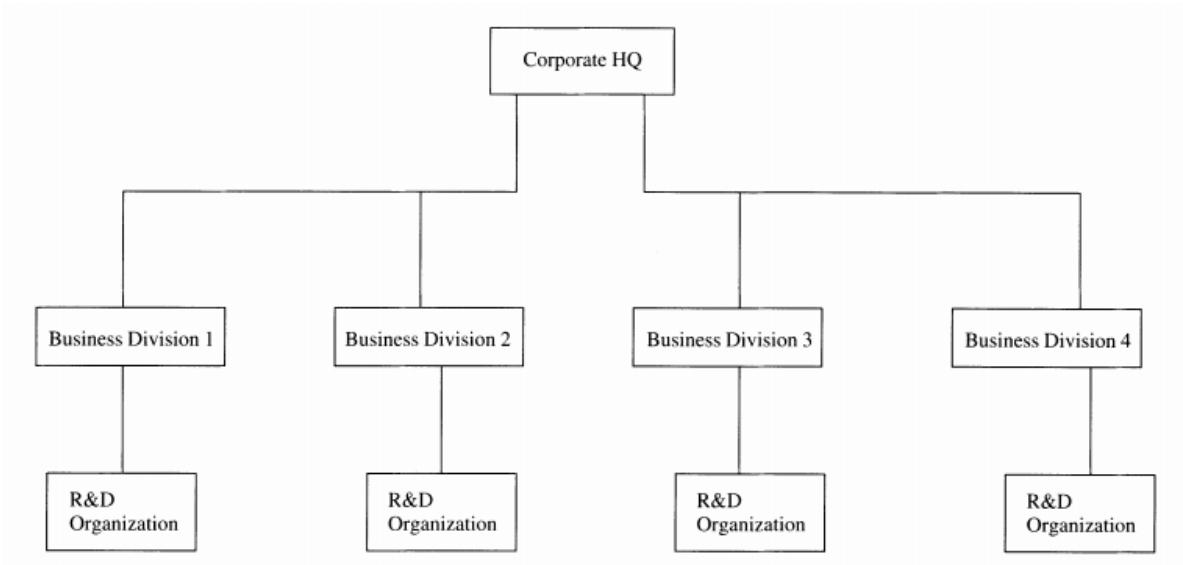

Figure 2. Decentralized R&D structure. [6]

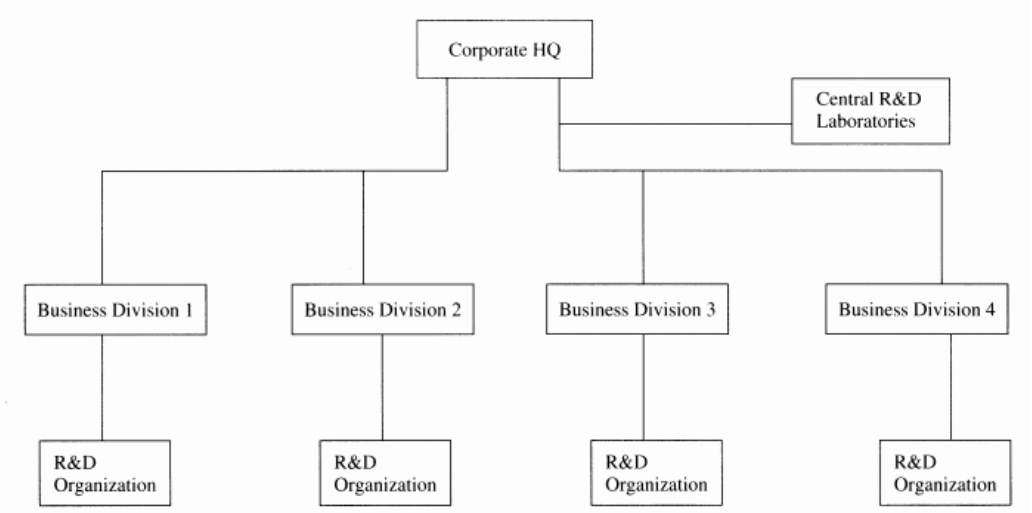

Figure 3. Hybrid R&D structure. [6]

R&D structure choices have been shown to affect the nature of a firm's innovative efforts and outcomes. Researchers in centralized structures are motivated to produce innovations that benefit the firm as a whole. For example, multidivisional firms whose R&D activities are centralized tend to invest more in R&D, to generate more

scientific publications, and to produce more patents [5,7]. This has been interpreted to mean that such firms' strategies emphasize internal R&D and patenting more than firms whose R&D is decentralized or hybrid in form. Centralized firms also produce innovations with larger and broader impact on the economy generally, as reflected in patent citations. This effect is believed to stem from the fact that centralized R&D incentivizes researchers to produce innovations that are applicable to the firm broadly, rather than to the product lines of their single, pre-specified division or sub-unit. Thus innovation in centralized R&D units might aim at entirely new products over which no division has yet been assigned authority. [6,7] The centralized R&D structures better support radical innovation while decentralized R&D structures better support incremental innovation. The preponderance of hybrid structures is striking, because there has been relatively little written about hybrid internal structures in general, much less hybrid R&D structures in particular. [5,6]

Dr.Traitler and his colleagues have explained the structure of food industry research and development in the following way.[3] According to Figure 4, the proposed structure is a hybrid food industry research and development unit. The whole R&D unit operates centrally under the supervision of the CEO and this unit is divided into different parts according to the subject and operates decentral under the supervision of the R&D manager.

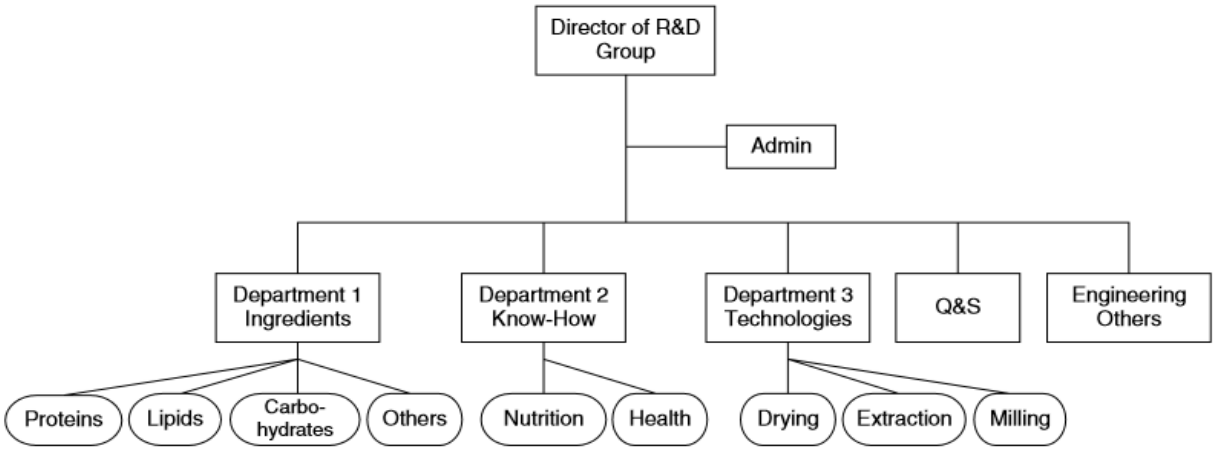

Figure 4. Simplified and typical structure of R&D in a food company. [3]

Approach design and decision making in R&D

Based on Thomas et al research, a good R&D structure fits both a company's Innovation Game and the relevant macro-trends for the company/industry. [7]

R&D strategy, which defines the approach to implementing an Innovation Game, should also guide the selection of an R&D structure, because it greatly influences the frequency and nature of interactions among R&D employees. The organizational structure likewise influences reward systems and, therefore, employee behavior. It is important to remember that a mismatched structure can defeat attempts to implement a good strategy. [7]

An Innovation Game, by which a company creates value for its customers and captures some of that value for itself, is characterized by the dominant approach to innovation, level of investment and effort in innovation, R&D capabilities, strategies and organization, as well as the company's competitive advantages and position in an innovation network/ value chain. Each of the seven Innovation Games exhibits a characteristic approach to structuring its R&D activities (Table 1). [7,8]

The first step is to consider the company's current R&D structure in light of its scope.

The second step is to identify which of the seven Innovation Games the company is playing. As shown in Table 1, each game has a characteristic approach to R&D. Thus, it is necessary to determine which parts of the R&D structure fit (or do not fit) the game a particular company is playing. One might also consider features of the R&D structure associated with a secondary game. The third step is to anticipate migration to a different Game. Several "natural migration" paths have been identified, e.g., from Science Based Safe Journey to Innovating in Packs. Thus, a company should identify where it is on the maturity curve for its current game, and assess how soon it may need to migrate to a different game. Likewise, a company may make a decision to change its game to support a new strategy. [7]

The final step is to superimpose trends that affect the realization of an R&D structure. Using the four steps in Figure 5 to design (or re design) an R&D structure facilitates the analysis of key issues regarding a company's current structure, pros/cons of centralized/decentralized/ hybrid structures, as well as business- and market specific issues. A good R&D structure balances both long-term dynamics (Innovation Games) and short-term dynamics. [7,8]

Based on personal experience, the most innovative game used in the food industry is Optimizing and Innovating in packs and the second science-based safe journey.

Table 1. Characteristic R&D Structures of the Seven Innovation Games [7]

Innovation Game	Example Industries/Companies	R&D Approach and Structure
Science-Based Safe Journey	Pharmaceutical, e.g., Aventis, Merck	Centralized R&D with partnerships/ alliances and contract R&D.
Technology Races	Biotechnology, e.g., Altarex. Fuel cell technology, e.g., Global Thermoelectric.	R&D is the primary focus and typically centralized
Battles of Architectures	Telecom (Bluetooth standard), e.g., SR Telecom, Motorola, with its third-party suppliers, e.g., Avaya, Freescale.	R&D is centralized but within an ecosystem of interdependent partners sharing the same goal.
Battles of Research, Development, and Engineering Systems	Chip design, e.g., Synopsys. Rational drug design, e.g. Arqule. Product lifecycle management, e.g., Dessault.	Highly centralized R&D with minor contractual outsourcing. These companies are typically in emerging markets.
Learning, Marketing, and Mass Manufacturing	Automotive, e.g., Ford, GM, Toyota, Daimler-Chrysler. Aerospace, e.g., Boeing, Airbus.	Centralized R&D with some decentralization to manufacturing plants. Centralization is necessary so that developments fit with diverse subassemblies and manufacturing processes.
Systems Engineering and Consulting	Information systems, e.g., Cambridge Technology Partners.	Centralized R&D is embedded in the company. R&D is performed as part of professional services and not as a separate R&D effort.
Optimizing and Innovating in Packs	Industrial gases, e.g., Air Liquide, Air Products and Chemicals.	Hybrid structures allow R&D to be done in partnership with customers. The decentralized part of R&D is done close to clients.

Aminullah et al. in 2018 R&D food industry engage in three types of innovation: i) management innovation by establishing the standardised management system in every country; ii) product innovation by developing new product regularly and developing new flavours from recipe contest; iii) position innovation by changing the context of products framed from instant food producer and shifting to be a part of food nutrition producer. Table 2 lists the types of innovations with the above three. [8]

Table 2. Drivers of Innovation for food industry. [8]

Firms	Areas Technology types	Technology levels	Innovation		
			Type	Sources	Drivers
Food processing	Low tech with advance machinery support	Technology acquisition and assimilation	●Product ●Management ●Position	●Market/user needs ●Business risk/ competitor ● Traditional Indonesian recipes ● Outsourcing research	Integrated business system

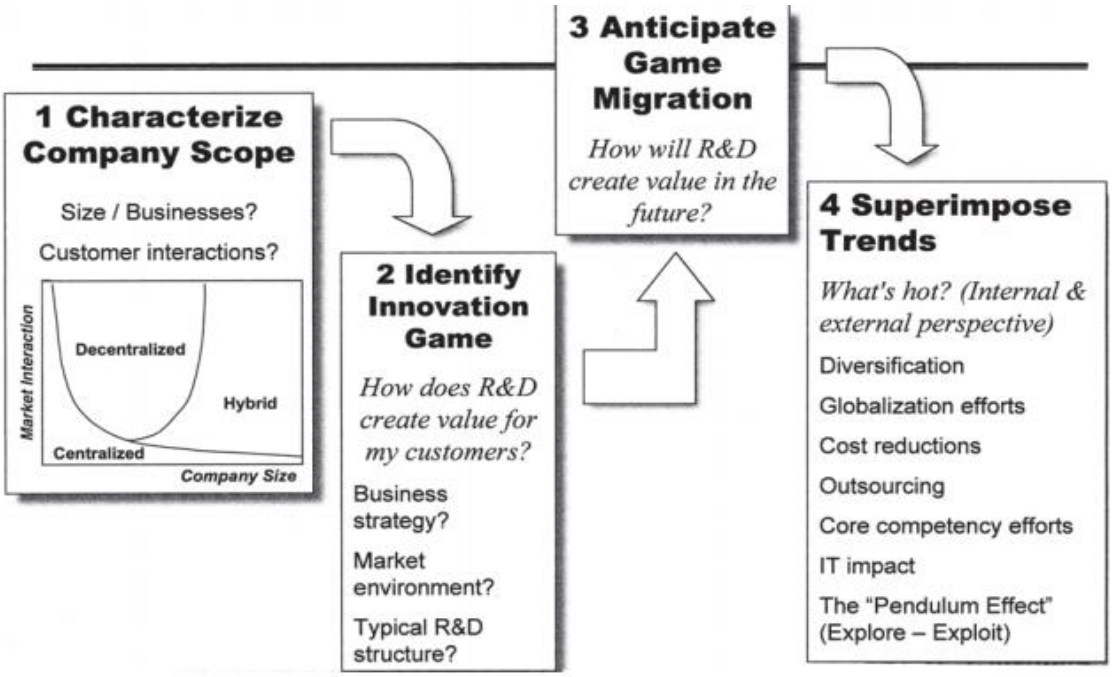

Figure 5. Decisions about R&D structures need to consider four key elements: company scope, strategies for value creation, changes in value creation, and internal/external trends. [7]

Manpower for R&D

Dr. Traitler in figure 6 illustrates the various types of people typically found in the food industry and especially in its R&D organization suggested two main types of characters, split into six classes. The two main classes are hoppers and stayers. These may be subdivided into super hoppers, opportunity hoppers, nepo hoppers, habit stayers, enthu stayers, and last but not least the no perspective stayers. They seem to be forming an almost natural habitat in every R&D organization and need to be managed carefully. [3]

He defined the hoppers as those who have not much patience to remain in any function or any job longer than they think might be necessary, and that they have, mostly according to them, achieved everything that could be achieved during their tenure in a particular function. The following is a brief description of each type. Typically, "Super Hoppers" are people with a strong ego, probably full of themselves and with a super strong belief into their capabilities, possibly overestimating these, sometimes, hopelessly. "Opportunity-hoppers" are the

flexible people in the organization who are always on the lookout for a possible new position while they typically loyally hold on to their current position and the projects that come with it. The third group of hoppers, a group called the "nepo-hoppers," where nepo stands for nepotism. Every company has these types of people; they are probably more numerous in positions outside R&D where profound university education and experience is maybe less of a requirement. [3]

On the other hand, one can find many stayers, those who are afraid to move on and who always have the feeling that they still have something to discover and add to their present function. These are actually the backbone of every R&D organization because only time and one's own will adds know-how and wisdom. [3]

Members of "Habit Stayer" tend to take their work outside, home, or to social gatherings and thereby possibly stumble across surprising innovations, the repetitiveness of the daily actions, possibly resulting in a kind of laziness of mind. The next subtype of the stayers could be called "enthu-stayers," where enthu stands for enthusiasm. Enthusiasm characterizes a typically large group of R&D people who are so excited and enthusiastic for their work and the projects they can contribute to, based on the important know-how that they have acquired through studies and practical experience. In general, this is a good group to have and most of its members are self-starters and need much less attention than the habit-stayers. This is not to say that one should forget them; they still need the recognition of their achievements more than anything else. There is a third subtype of stayers, which I would call "no-perspective-stayers." Most often, members of this subtype develop from the habit-stayers, who remained too long in a cozy and nice position, not realizing that over time the opportunities for them became rarer and rarer. All of a sudden they may find out that there are no more new challenges there for them and they have lost all real work perspective. This is often a slow and hidden process that neither the person nor his or her boss or management have noticed when it was still possible to rectify and correct the situation. This is probably the most difficult group to deal with, and there is no one recipe for correcting and resolving the situation. [3]

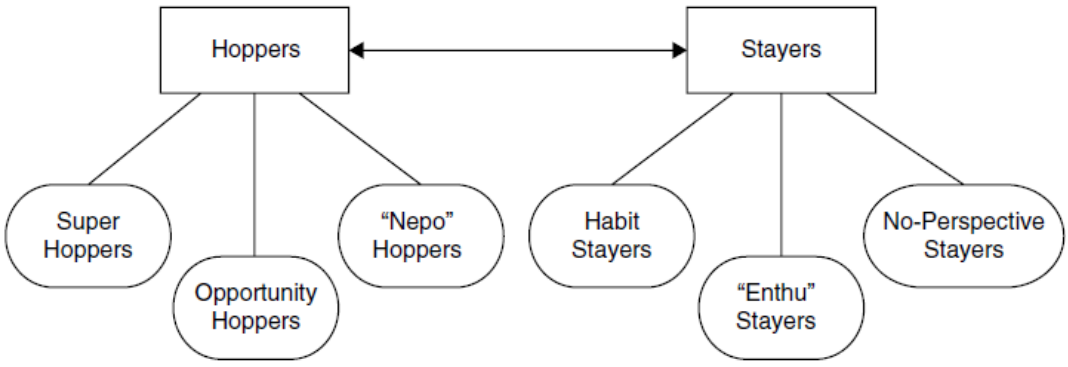

Figure 6. people in food industry R&D.[3]

In an R&D environment, creativity and innovation are top priorities. Having a team that is equipped for that job is of the highest importance. Such a team must possess both the right hard skills and soft skills. Getting the hard skills on board is easy because employees must show their educational and experience background. Getting the right soft skills within a team is a more challenging task. Putting the best knowledgeable people in one team does not guarantee success – soft skills are equally important. [9]

Belbin is a diagnostic tool for teams and individuals aiming for better teamwork. Belbin helps to discover the behavioral

strengths and weaknesses of the individuals that you work with. It is used to help build high-performing teams, maximize working relationships, and enable people to learn about themselves. [9,10]

Belbin way first and foremost identifies what skills exist within a team and who has them. Once you have worked out your own role within a team, it is then important to acknowledge and appreciate the contributions of others. Once the whole team has been categorized, you can then identify where gaps may exist within the team, as well as any duplicate roles. Belbin argues that duplicate roles carry as much danger as ones not being carried out, as they can lead to a waste of resources, high levels of stress and confusion. Figure ۷shows the types of roles and behaviors of individuals in the Belbin s team. A successful R&D unit should include all roles. [9,10,11]

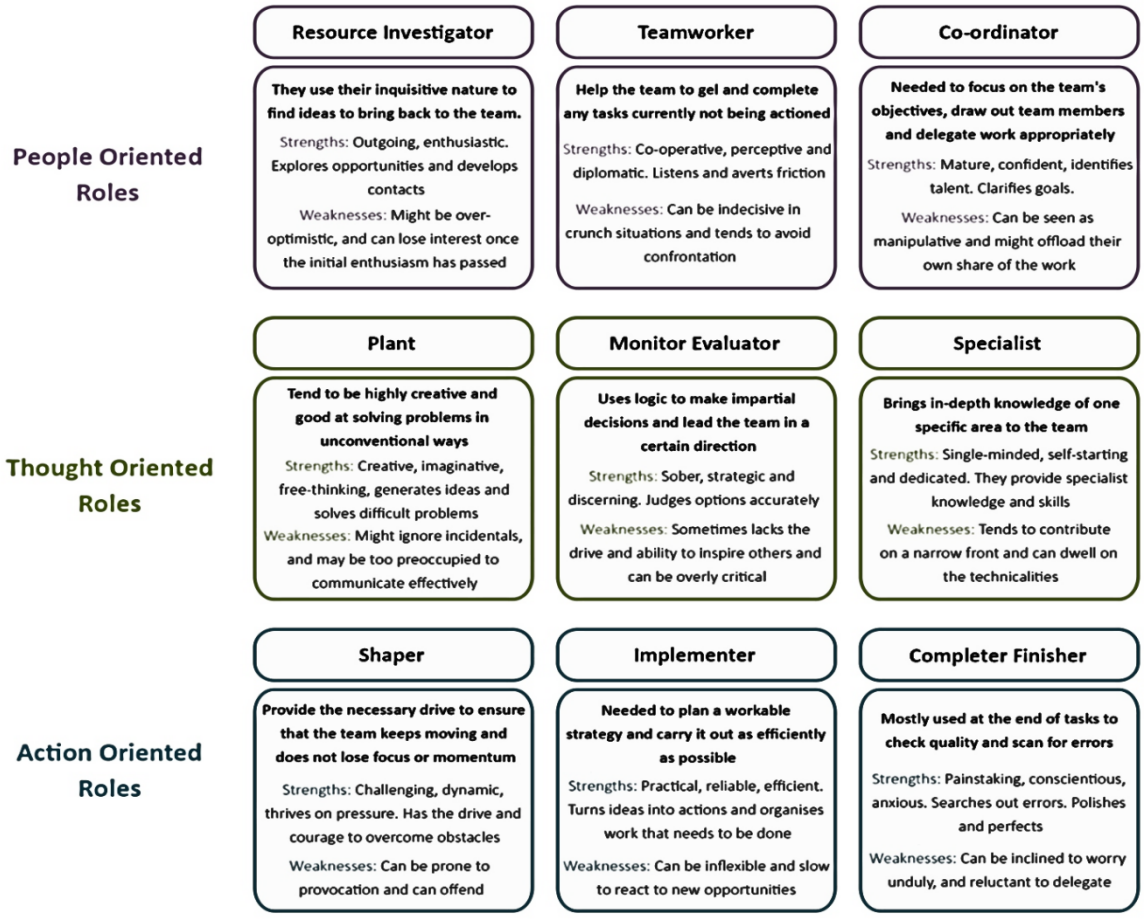

Figure 7. Belbin s team[11]

Project in R&D

All projects in any company in the world of R&D or outside should always be based on two major reasons: strategy and business need .By looking based on Dr. Traitler personal experience, he could make out eight different types of projects. Here we go:

Figure 8 illustrates the various types of projects and their main characteristics. [3]

- The briefed, strictly business-based and justified projects or the business project
- The secret project
- The pet project
- The never-ending project
- The trial-and-error project

- The please-someone project
- The defensive project
- The knowledge-building project

The most important activity in the R&D of a food industry unit is the create a new product. First, let's take a look at the production of a new product in the last few decades.
According to Laidens (2007), the food industry has the characteristic to release a large number of products per year. Nonetheless, projects lack definition and systematization, contributing to a high failure rate. This can occur because, in most food industries, projects are based on empirical procedures and based only on knowledge, skills and experiences of the individuals . Toledo et al. (2008) report that product development is a complex process and of broad scope, and any research in this area has limitations and a wide range of critical success factors. According to Salgado et al. (2010), the product development process refers to the steps, activities, tasks, stages and decisions involving the product development project. Clark & Fujimoto (1991) define product development as the process by which the organization transforms data on market opportunities and technical possibilities in goods and information for the manufacture of a commercial product.[12]

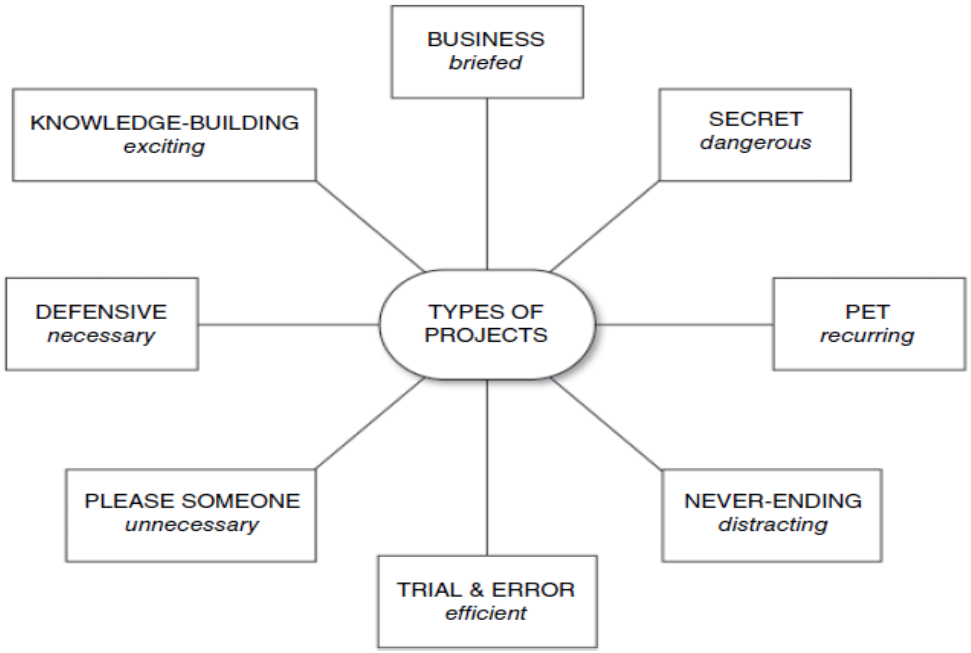

Figure 8. Types of project. [3]

New product development (NPD) is the process of designing a new product, producing it and bringing it to market. Most new food products, particularly those produced by small- and medium-sized enterprises, are developed based on company-specific NPD procedures or models adapted from other sectors [13]. Little standardisation exists, which is a major problem because in food production factors such as consumer health, availability and access to ingredients, resilience of food supply chains, sustainability of ingredients and, more generally, management of the food product's lifecycle must be taken into account consistently. An opportunity exists for a formalised, specific-food-sector NPD process. To be able to envision what such a process would look like, one must first understand the strengths and shortcomings of the most common NPD models and explore how they have been adopted. One must then consider the unique challenges of the food-manufacturing sector. Here's how

to put one together for use with your new product.[14]

In the following, a model of the production process of a new product in the food industry is presented (Table ٣). The initial input of this model is Customer desire .The method starts with the client's expression for his desire, what he expects for the product to be developed. The client can be external or internal. Domestic demand may come from various sectors: a) marketing; b) industrial; c) research and development; d) costs; e) commercial; f) management; g)Suggestion system. External demand may come from various :a) Customer complaints; b)Ideators outside the organization.Pre-development, the first stage, entails assessment of market needs, internal capabilities, potential products that could match these and, finally, associated business models. Development, the second stage, consists of prototype development, testing and refinement. Post development, the third stage, comprises launch, product performance in the market and feedback into subsequent NPD.[12]

Table 3. Proposed method for the generation of new products (NPD). [12,13]

	Input	**Output**	**Tools**
1st Step: Customer desire	1. Customer desire 2. Product visualization (if there is)	1. Product information 2. Product information registration 3. Record of learning	1.Text editor 2.stage checklist.
2nd Step: Perception	1. Product information 2. Product information registration	1. Perceptions on the product 2. Registration of the perceptions on the product 3. Record of learning	1. Five human senses 2. Text editor 3. Stage checklist
3rd Step: Insights.	1. Perception on the product 2. Registration of the perception on the product	1. Generated ideas. 2.Registration of the generated ideas. 3. Record of learning	1. Brainstorming 2. Rich Picture 3. Cognitive mapping 4. Text editor 5. Stage checklist
4th Step: Selection of ideas.	1. Generated ideas 2. Registration of the generated ideas	1. Selected ideas 2. Registration of the selected ideas 3. Record of learning	1. 5W2H[1] 2. Choice committee 3. Criteria Chart 4. Text editor 5. Stage checklist

[1] 5W2H (What, Why, Who, When, Where, How, How Much): "what" to run, "why" it should be run, "who" must run, "when" it will be run, "where" it should be run, "how" it should be run, and "how much" it will cost to run.

5th Step: Ideas X SP.	1. Generated ideas 2. Registration of the generated ideas	1. Appropriate ideas to the process 2. Registration of the appropriate ideas to the process 3. Record of learning	1. Vision, Mission and Values of the company 2. Strategic plan of the company 3. Text editor 4. Stage checklist
6th Step: Product Requirements.	1. Appropriate ideas to the process 2. Registration of the appropriate ideas to the process	1. Technical, financial and legal requirements of the product 2. Registration of the product requirements 3. Record of learning	1. Reverse Engineering 2. Benchmarking 3. Quality function deployment 4. Checklist 5. HACCP 6. ISO 22000 7. Text editor 8. Stage checklist
7th Step: Process requirements.	1. Technical, financial and legal requirements of the product 2. Registration of the product requirements 3. Evaluation of the product's adequacy to the process 4. Registration of the product's adequacy to the process	1. Technical, financial requirements of the process 2. Registration of the process requirements 3. Record of learning	1. Text editor 2. Stage checklist
8th Step: Availability.	1. Technical, financial and legal requirements of the product 2. Registration of the product requirements 3. Technical, financial requirements of the process 4. Registration of the process requirements	1. Availability of ingredients, inputs and equipment 2. Registration of availability 3. Datasheets of ingredients, inputs and equipment 4. Record of learning	1. Text editor 2. Stage checklist
9th Step: Scope registration	1. Registration of the product information 2. Perception on the product 3. Technical, financial and legal requirements of the product 4. Evaluation of the product's adequacy to the process 5. Technical and financial requirements of the process 6. Availability of	1. Product and process scope 2. Registration of the scope 3. Record of learning	1. Text editor 2. Stage checklist

	ingredients, inputs and equipment		
10th Step: Evaluation.	1. Product and process scope 2. Customer desire	1. Approval of the scope of the product and process OR 2. Non-approval of the scope of the product and process 3. Record of learning	1. Text editor 2. Stage checklist

Conclusions

The food industry is really a champion in complexity and to be able to grasp and define how the food industry at large views and drives necessary changes to their R&D organizations, the following is useful to understand this complexity better. The food industry consists of these elements:

• Agricultural development
• Farming and animal husbandry
• Raw and packaging materials suppliers
• Branded products research and development and their manufacture
• Distribution, distributors, logistics, and retailers
• Private label manufacturers

First, people are selected to work in the research and development unit through Belbin test, and after training them, they should be constantly looking for ways to increase their creativity and innovation. According to the structure of the company, the type of structure of the research and development unit is selected. After the new product enters the market, the research and development unit constantly monitors the product in the market and changes it again if necessary.

It is suggested that research and development using new methods enrich new markets on the arrival of a new product.

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