A Research of Affecting Factors on R&D Management in Food

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ABSTRACT

The purpose of this study was to analyze the R&D approaches of business managers and the factors that affect R&D activities in the central districts of the province of Konya in Turkey. The main data of the study were collected by questionnaires that were applied with managers of 67 businesses in the food industry who were determined by the method of quota sampling. Ac-cording to the results, the effects of the educational status of the business owner, the personnel structure of the business, the date when the business was established, having a plan for R&D activities for the next 5 years, whether or not they had knowledge on the institutions that provide support for R&D projects and the level of collaboration with universities on the R&D activities of businesses were significantly effective on the level of 5%. The variables that were related to the R&D perceptions of the business managers were determined by factor analysis, and it was found that there were 5 factors regarding the R&D perceptions of the managers. Regression analysis was used to determine whether or not the factors related to R&D perceptions were effective on conducting R&D activities. As a result of the regression analysis, it was determined that R&D had contribution in the operations of the business (Factor I), and the two factors related to universi-ty-industry collaboration (Factor V) had significant effects on businesses' R&D activities on the level of 5%.

1. Introduction

In today's conditions, in order for countries to take a prominent position in the international arena in the sectoral sense, they need to pay importance to innovation activities in their production processes. To achieve this power, they must conduct R&D activities (Dahlman 2007). With the help of R&D and innovation, businesses operate more effectively and efficiently, and consumers are more satisfied (Rajapathirana & Hui 2018). The advanced technology practices of a country contribute to the increase in the prosperity in the country, and therefore, higher living standards (Samimi & Jenatabadi 2014).

R&D activities have an important place in the agriculture and food industry and in increasing the competitive power of countries like Turkey, which have a high potential for agriculture. By applying R&D activities on the production models in the food industry, it will be possible to achieve an economic model where the continuity of employment and efficiency are increased, revenue is raised bilaterally between the producers and industrialists and the state, and social prosperity is achieved (Tan et al. 2017). Businesses may operate transformation activities by conducting R&D activities

(Barro 1990). The information which is accessed by the R&D activities in economic sectors allows higher levels of production without additional costs (Silva & de Carvalho 2015). The importance that is paid to R&D is higher in new economic systems (Bozkurt 2015). This is why investments on R&D are considered to be an indicator of the effort of the economy to bring innovation (Pandit et al. 2009).

The food sector, which has developed a lot in recent years, is among the most important economic sectors in Turkey (Ozden & Senkayas 2012; Gursakal et al. 2015). The food sector is a branch of the manufacturing sector which converts plant- and animal-based raw materials that are obtained as a result of agricultural activities into products with long shelf life that are ready for consumption by using multiple different processes (Bulu et al. 2007). In the food sector, Turkey is mostly involved in production that is dependent on imported technology. Additionally, there are significant shortcomings in adapting the imported technology to the conditions in the country (Kuşat 2012). Several practices were carried out in Turkey after 2010 within the scope of the National Science, Technology and Innovation Strategy for the Period of 2011-2016 to determine the priorities of various sectors in science, technology and innovation. The ne-

cessity of need-based R&D was emphasized in six sectors that require accelerated development as the defense, space, health, energy, water and food sectors. Additionally, in these fields, strategies were adopted to improve human resources for innovation in science technologies, convert research outcomes into goods and services, spread the culture of multidisciplinary R&D collaboration, increase the role of SMEs in the national system of innovation, raise the contribution of the R&D infrastructure in the field of Turkish research and make the innovation in international science technologies effective.

In order to improve R&D and innovation policies and strategies in both the food industry and other industries, it is needed to determine the approaches of businesses in the nationwide sectors on this field. Therefore, it is important in this study to determine the R&D approaches, attitudes and behaviors of business managers of food industry businesses in the province of Konya in Turkey which has a high potential for agriculture and thus a developed food industry, in terms of revealing the existing situation regarding the R&D activities in the food industry.

2. Materials and Methods

The main material of the study consisted of the primary data that were collected with questionnaires used in 67 businesses in the food industry in the central districts of the province of Konya (Karatay, Meram, Selçuklu). Additionally, studies carried out by various organizations and institutions on the topic and statistics were utilized.

The quota sampling method was used to determine the number of the businesses to be included in the study (Acharya et al. 2013). Accordingly, this number was determined as 67. This number represents 24% of all food industry businesses in the region.

The attitudes, behaviors and perceptions of the business managers of the businesses in the food industry in the central districts of Konya were analyzed using a 5-point Likert-type scale. A Likert-type scale is the most practical method for measuring attitudes. This is why this method is used prevalently for attitude scales (Hoyle et al. 2002; Yilmaz et al. 2019; Türker 2007)

A factor analysis was carried out to categorize the factors that affect the R&D perceptions of the business managers of the food industry. Kaiser-Meyer-Olkin (KMO) test was used to determine whether or not the data were suitable for factor analysis (Keleş 2019). High rates of variance as a result of factor analysis show that the factorial structure of the scale is strong (Yong & Pearce 2013).

A logistic regression analysis was conducted to determine the factors that affect R&D activities. The logit model is a statistical model that allows a categorization that is appropriate for the rules of probability by probabilistically calculating the estimated values of the dependent variable and analyzes tabulated or raw datasets (Gujarati 2009). Based on studies in the literature, it was

determined that the logistic regression model was suitable for this study, and it is frequently used to analyze similar data (Powers & Xie 2008; Unlüer & Günes 2013; Gençdal et al. 2015; Christoforou et al. 2018; Öz & Saner 2021)

The general functional representation of the Logit models is as follows (Gujarati 2009);

$$P(Y) = \frac{e^{(\beta_0 + \beta_1 \beta_1)}}{(1 + e^{(\beta_0 + \beta_1 X_1)})}$$

Dependent variable is whether or not to do R&D.

P(Y) = Probability of being dependent variable

e= The natural logarithm of 10 base and approximately 2.30

X_i = Number of explanatory variables

\beta_0\ and\ \beta_1 =Typically estimated by the maximum likelihood (ML) method (Berenson et al. 2012).

The odds rate (OR) used to interpret the logistic regression model is the value obtained by dividing the probability of observing the event by the probability of not observing the event. It is calculated as;

$$OR = \frac{P(Y)}{1 - P(Y)}$$

Mann Whitney U test was used to determine the factors that affected R&D activities among the businesses in the food industry in the central districts of Konya that carried out R&D activities and those that did not conduct R&D activities. Mann Whitney U test is used to determine the differences between two independent variables that are measured continuously. It is the non-parametric equivalent of t-test, which is a parametric test used to determine whether or not the difference between two independent variables such as an X and a Y is significant (it compares the median values of the variables) (MacFarland & Yates 2016).

3. Findings and Discussion

3.1. Some Socioeconomic Characteristics of the Businesses in the Food Industry

As some of the socioeconomic characteristics of the food industry businesses that were examined, the study collected data on the business managers' educational status, personnel status, the date of establishing the business, annual revenue, library situation and whether they advertised or not. It was found that most food industry business managers in the region (59.70%) had undergraduate degrees. The educational levels of the business managers in the region were higher than those of the agriculture-based industry business managers in the province of Samsun (Mazgal 2005). 46.27% of the studied businesses had 10-49 employees, 19.40% had 1-9 employees, 17.91% had 50-99 employees, and 16.42% had 100 or more employees. The personnel status of the businesses in the studied region was similar to those in the food industry in the province of Tokat and the industry sector in (Yalçın & Esengün 2008; Üçler & Karaçor

2014). The studied businesses had different dates of establishment. The highest rate of the businesses (29.85%) were established in the period of 1971-1990. 25.37% of the businesses were established in 1991-2000, 20.90% were established in 2001-2010, 11.94% were established in 1950-1970, and another 11.94% were established in 2011 or later. It was determined that the food industry businesses in the studied region were usually established after 1998 in similarity to the dates of establishment among the agriculture-based industry businesses in the province of Van (Ulas & Cakir 2006). 58.21% of the studied businesses had annual revenues of higher than 1,000,000 TL, 16.42% had annual revenues in the range of 751,000-1,000,000 TL, 8.96% had annual revenues in the range of 101,000-250,000 TL, 7.46% had annual revenues in the range of 251,000-500,000 TL, 4.48% had annual revenues of 501,000-750,000 TL, and another 4.48% had annual revenues of lower than 100,000 TL. It was reported that the annual revenues of the studied businesses were similar to those of the food industry businesses nationwide, and their annual revenues usually exceeded 1,000,000 TL (Bakkaloglu & Günes 2018).

3.2. The State of R&D in the Studied Food Industry Businesses

While 56.72% of the food industry businesses that were studied conducted R&D activities, 43.28% did not. It was determined that the rate of conducting R&D activities among the studied food industry businesses was higher than those of the agriculture-based industry businesses in the provinces of Çanakkale and Samsun and the food industry businesses nationwide (Mazgal 2005; Tan et al. 2017; Bakkaloglu & Günes 2018). It was observed that the vast majority (61.19%) of the studied

food industry businesses planned to conduct R&D activities in the next 5 years. Among the studied businesses, 61.19% had knowledge about the institutions that provide support for the R&D projects and activities of the food industry businesses in the studied region. In terms of the sources of financial R&D support that were utilized in the food industry businesses, it was determined that 19.40% used support by KOSGEB (the Small and Medium Enterprises Development Organization of Turkey), and 11.94% used support by TÜBİTAK (the Scientific and Technological Research Council of Turkey).

Mann Whitney U test was conducted to determine whether or not some of the socioeconomic characteristics of the businesses were effective on their usage of R&D activities (Table 1). The findings that were obtained as a result of the analysis are described below.

In terms of conducting and not conducting R&D activities, the effects of the educational status of the business owner, the personnel structure of the business, the date when the business was established, having a plan for R&D activities for the next 5 years, whether or not they had knowledge on the institutions that provide support for R&D projects and the level of collaboration with universities on the R&D activities of businesses were significantly effective on the level of 5%.

No significant relationship could be found between whether or not the studied businesses conducted R&D activities and their annual revenues, library situations, levels of advertising, state of following the R&D activities of competitor firms and needs for receiving counselling support within the scope of university-industry collaboration.

Table 1

Determination of properties of businesses conducted R&D activities and non-R&D activities by Mann Withney U test

	R&D Situations	N	Mean Rank	Sum of Ranks	Asymp. Sig. (p)
The effects of the educational status of the business owner	R&D	38	38,09	1447,50	,030
	Non-R&D	29	28,64	830,50	
Personnel structure of the businesses	R&D	38	38,53	1464,00	,029
	Non-R&D	29	28,07	814,00	
The date when the business was established	R&D	38	29,68	1128,00	,034
	Non-R&D	29	39,66	1150,00	
Annual revenues	R&D	38	31,53	1198,00	,183
	Non-R&D	29	37,24	1080,00	
Library situations	R&D	38	35,88	1363,50	,225
	Non-R&D	29	31,53	914,50	
Level of advertising	R&D	38	36,42	1384,00	,168
	Non-R&D	29	30,83	894,00	
Having a plan for R&D activities for the next 5 years	R&D	38	38,18	1451,00	,017
	Non-R&D	29	28,52	827,00	
State of following the R&D activities of competitor firms	R&D	38	36,18	1375,00	,197
	Non-R&D	29	31,14	903,00	
Whether or not they had knowledge on the institutions that provide support for R&D projects	R&D	38	39,95	1518,00	,001
	Non-R&D	29	26,21	760,00	
The needs for receiving counselling support within the scope of university-industry collaboration	R&D	38	35,08	1333,00	,506
	Non-R&D	29	32,59	945,00	
The level of collaboration with universities on the R&D activities of businesses	R&D	38	37,08	1409,00	,040
	Non-R&D	29	29,97	869,00	

The perceptions, attitudes and behaviors of the business managers on R&D were investigated, and the results are presented in Table 2.

Table 2
R&D perceptions, attitudes and behaviors of the food industry enterprises examined

Opinions about R&D management	Mean*	Standard Deviation	Variance
In general, Turkey has done enough in R&D.	1,99	0,913	0,833
Public institutions in Turkey are allocating sufficient resources to R&D activities.	2,21	0,897	0,804
Private sector in Turkey are allocating sufficient resources for R&D activities	2,33	0,975	0,951
In Turkey, R&D activities are in the development stage.	2,88	0,930	0,864
In Turkey, the share allocated to R & D is sufficient.	2,28	0,831	0,691
In Turkey, not given required importance to R&D	3,63	0,935	0,874
The knowledge of the country is not sufficient for R&D.	3,75	0,766	0,586
Technology development activities in the country are in good condition.	2,66	0,880	0,774
Konya has an R&D potential that you work.	2,85	0,973	0,947
Original products are only possible with R&D.	3,88	0,808	0,652
R&D activities are important for businesses.	3,84	0,828	0,685
There is a need to collaborate with universities in Food Industry.	3,09	1,125	1,265
Businesses should allocate at least 10% of their budgets for R&D activities.	3,66	0,930	0,865
R&D is the primary precaution for product development.	3,88	0,789	0,622
There is a direct correlation between companies' R&D investments and their competitiveness.	4,01	0,663	0,439
Technology developed with R&D studies will increase the competitive power of the company.	4,00	0,674	0,455
The activities of competitors must also be considered in R&D studies.	3,97	0,717	0,514
Investors believe that the success and development of the company will be more successful with innovation.	3,85	0,875	0,765
Businesses have knowledge about technological developments with R & D.	3,97	0,521	0,272
Businesses have information about businesses in the sector with R & D.	3,94	0,600	0,360
Businesses have information about new equipment with R & D.	3,93	0,635	0,403
Businesses have knowledge about R & D, Cost and sales strategies.	3,73	0,709	0,502
Businesses Have information about the market with R & D.	3,69	0,783	0,612
Your organization is systematically monitoring technology and markets to maximize development.	3,22	1,012	1,025
R & D expenses in your company are considered as investment rather than cost.	3,06	1,099	1,209
If cooperation with the university is requested, our business will participate	3,16	1,298	1,685
Our business does benefit from public / private R & D support.	2,66	1,136	1,289
The importance of R & D activities in business is given.	3,31	1,117	1,249
Technological developments and innovations are constantly monitored in our business.	3,40	1,102	1,214
Our business is updating its strategy according to R & D activities.	3,34	1,038	1,077
R & D activities / investments / expenditures carried out in our business are contributing as a competitive advantage	3,37	1,139	1,298
R & D activities / investments / expenditures carried out in our business contribute to growth and efficiency output.	3,36	1,151	1,324
R & D activities / investments / expenditures carried out in our business contribute to production output.	3,37	1,153	1,328
R & D activities / investments / expenditures carried out in our business contribute as a product variety output.	3,33	1,160	1,345
R & D activities / investments / expenditures carried out in our business contribute to the original design / innovation output.	3,30	1,168	1,364
R & D activities / investments / expenditures carried out in our business contribute to patent output.	3,13	1,192	1,421

*Strongly agree:5, agree:4, neutral:3, disagree:2, strongly disagree:1

The Kaiser-Meyer-Olkin (KMO) test statistic of the attitudes and behaviors of the business managers on R&D was 0.808. This result showed that the distribution of the data was suitable for factor analysis. The significant Bartlett's test result of 2762.022 (p<0.001) showed that the data had a multivariable normal distribution. As a result of the analysis, it was determined that the related variables were gathered under 5 factors. 70.04% of the total variance was explained cumulatively by these 5 factors (Table 3).

Table 3
R&D perceptions, attitudes and behaviors of the foodindustry enterprises examined

Factor	Initial Eigenvalues			Total Factor Loads			Turned Totals of Factor Loads		
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
1	15,080	41,890	41,890	15,080	41,890	41,890	10,510	29,195	29,195
2	4,005	11,125	53,015	4,005	11,125	53,015	4,524	12,567	41,762
3	3,040	8,443	61,458	3,040	8,443	61,458	3,997	11,102	52,864
4	1,792	4,977	66,435	1,792	4,977	66,435	3,261	9,059	61,923
5	1,297	3,601	70,036	1,297	3,601	70,036	1,873	5,203	67,127
6	…	…	…						
36	0,002	0,006	100,000						

Kaiser-Meyer-Olkin Sampling Competence			0,808
Bartlett's Test of Sphericity	Khi Square Value		2762,022
	Degree of Freedom		630
	p		0,000

While conducting the factor analysis with the purpose of categorizing the factors that affected the R&D perceptions of the business managers, principal components analysis was conducted with the varimax rotation technique to gather information on the construct validity of the scale. As seen in Figure 1, when the initial eigenvalue was taken as 1.26 and as a result of the repeated factor analysis, 5 factors were determined. The high values of variance as a result of the factor analysis showed that the factorial structure of the scale was strong (Yong & Pearce 2013).
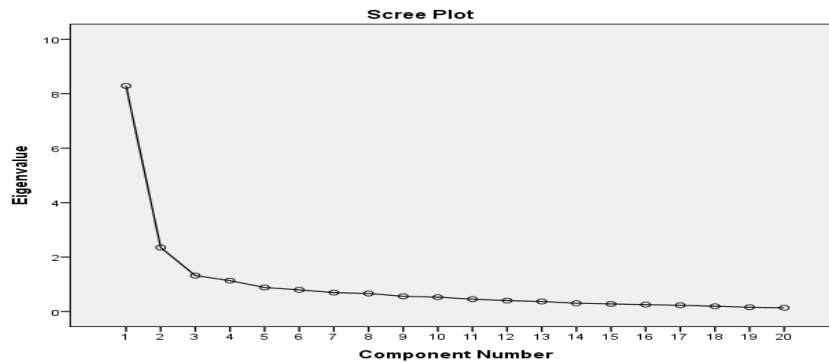

Figure 1

Aggregation graph for the items in the survey

As a result of the factor analysis on the 36 items that were examined to measure the perceptions, attitudes and behaviors of the business managers on R&D (Table 2), the related issues were gathered under 5 factors (Table 4). The factors where related variables gathered were described as; the contribution of R&D on the operations of the business (Factor I), the contribution of R&D on the competitive power of operations (Factor II), the contribution of R&D on technological development (Factor III), the contribution of the national R&D structure on businesses in the food industry (Factor IV) and the contribution of university-industry collaboration on the R&D activities of businesses in the food industry (Factor V).

Table 4

Factor Analysis of Perception, Attitude and Behaviors of Food Industry Management Managers Related to R&D

Factor Groups	Scale Items and Factor Loads	Number of İtems
the contribution of R&D on the operations of the business	İtem 35 (0,935), İtem 33 (0,928), İtem 34 (0,912), İtem 32 (0,907), İtem 31 (0,900), İtem 28 (0,840), İtem 36 (0,837), İtem 29 (0,828), İtem 30 (0,825), İtem 25 (0,795), İtem 27 (0,633), İtem 24 (0,629), İtem 9 (0,416)	13
the contribution of R&D on the competitive power of operations	İtem 15 (0,869), İtem 16 (0,854), İtem 17(0,711), İtem 14 (0,645), İtem 18 (0,599), İtem 10 (0,577), İtem 11 (0,457)	7
the contribution of R&D on technological development	İtem 21 (0,789), İtem 20 (0,775), İtem 19 (0,756), İtem 22 (0,756), İtem 23(0,702)	5
the contribution of the national R&D structure on businesses in the food industry	İtem 1 (0,887), İtem 2 (0,800), İtem 3 (0,774), İtem 8 (0,615), İtem 7 (-0,605), İtem 5 (0,585), İtem 6 (-0,473), İtem (0,458)	8
the contribution of university-industry collaboration on the R&D activities of businesses in the food industry	İtem 12 (0,667), İtem 13 (0,590), İtem 26 (0,491)	3

Logistic regression analysis was used to test the effects of the factors related to the perceptions, attitudes and behaviors of the business managers on whether or not they conducted R&D activities (Table 5). 2 of the 5 factors that were investigated in the model had significant effects. The dimensions that had significant effects were Factor 1 and Factor 5. The results showed that, when all the other conditions are kept constant, R&D contributed to the operations of businesses in the food industry, and the business managers that had a tendency to stated that university-industry collaboration contributes to improvement of R&D by businesses also had a higher tendency to conduct R&D activities.

Table 5
Logistic regression model

Name of Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Factor I.	1,729	0,408	17,994	1	**0,000**	5,633
Factor II.	0,467	0,382	1,495	1	0,221	1,595
Factor III.	0,121	0,366	0,109	1	0,741	1,129
Factor IV.	0,254	0,339	0,563	1	0,453	1,289
Factor V.	0,681	0,353	3,726	1	**0,044**	1,976
Invariant	0,337	0,330	1,047	1	0,306	1,401

4. Conclusions and Recommendations

This study investigated the R&D approaches of business managers of businesses in the food industry in the central districts of Konya in Turkey and the factors that affect the status of conducting R&D activities.

The personnel status of the businesses was significantly effective on the level of 5% on whether or not they conducted R&D activities. Accordingly, the number of employees and the experiences of the personnel regarding R&D should be increased at businesses that do not conduct R&D activities. Businesses should start systematic plans that would improve R&D activities and employ qualified personnel.

There was a significant relationship on the level of 5% between the businesses' dates of establishment and whether or not they conducted R&D activities. However, considering the effect of R&D on business success, without regard to their establishment dates, awareness about R&D should be raised in businesses for their continuity and sustainable competitive power.

Whether or not the business manager had knowledge on institutions that provide support for R&D projects was significantly effective on the level of 5% on whether or not they conducted R&D activities. It was seen that, although the majority of the business managers (61.19%) had knowledge about the institutions that fund R&D projects and provide assistance, they did not sufficiently utilize the available assistance. Regarding this issue, institutions that provide R&D projects and assistance should inform food industry businesses and establish collaboration with them.

There was a significant relationship on the level of 5% between the businesses' levels of collaboration with universities and whether or not they conducted R&D activities. Industry-university collaboration should be more prevalent for increasing the R&D activities of businesses in the food industry.

Considering the factors that are related to the perceptions, attitudes and behaviors of the business managers on R&D, it was found that the managers who had positive attitudes towards the idea that R&D contributes to the operation of the business in the food industry and the idea that university-industry collaboration contributes to improvement of R&D by businesses in the food industry had higher rates of conducting R&D activities in comparison to the other managers. In the light of these results, seminars and introduction activities should be planned for managers of businesses in the food industry regarding the importance and advantages of conducting R&D activities. It is needed to fill the gaps in the knowledge of business owners and personnel on R&D with workshops and similar meetings that involve experts from universities and different sectors.

Consequently, state-industry-university collaboration has great importance for businesses in the food industry. These organizations and institutions should perform the responsibility that falls upon them and work in coordination.

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