Original Article
http://mjiri.iums.ac.ir
Medical Journal of the Islamic Republic of Iran (MJIRI)

Med J Islam Repub Iran. 2022 (10 Oct);36.117. https://doi.org/10.47176/mjiri.36.117

Key Factors to Improve Pharmaceutical Industry's R&D Productivity: A Case Study of Iranian Pharmaceutical Holding

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Received: 6 Feb 2022 Published: 10 Oct 2022

Abstract

Background: Productivity is one of the most important factors of development in pharmaceutical companies, which is in direct contact with research and development (R&D) employees. The study aimed to identify and prioritize the effective factors for improving the R&D Activities of Iranian pharmaceutical holding.

Methods: This case study was performed by a questionnaire designed into two sectors, demographic profile data, and nine attitude factors. The questionnaire was distributed to Iranian pharmaceutical holding. The main sampling targets were managers and employees of the R&D department. Cronbach's alpha considered the reliability of the questionnaire, and the validity of the questionnaire was measured by the content validity method. Descriptive analyses were done using frequency, percentage, mean, standard deviation, and variance. Also, Kolmogorov–Smirnov, Pearson correlation coefficient, F test, and Friedman test were used as comparative and inferential analyses.

Results: A total of 65 questionnaires were collected (43 are men and 22 are women) from 11 companies of an Iranian pharmaceutical holding. The 5-10 years of work experience with doctorate education levels were common. Based on the ranking done on the data using the Friedman test method, economic factors were recognized as the most important and individual factors as the least important factors. People aged 35-40 years had a higher frequency. Furthermore, there was a significant difference between considered factors and productivity of R&D.

Conclusion: All current study's hypotheses show a significant difference in productivity in Iranian pharmaceutical companies.

Keywords: Iranian Pharmaceutical Holding, Productivity, Research and Development, Empirical Study, Key Factors, Pharmaceutical Industry, Case Study, R& D

Conflicts of Interest: *None declared*
Funding: *This study was supported by Iran University of Medical Sciences*

Cite this article as: Shabani A, Rajabi S, Alipanahi N, Ahmadi Teymourlouy A. Key Factors to Improve Pharmaceutical Industry's R&D Productivity: A Case Study of Iranian Pharmaceutical Holding. *Med J Islam Repub Iran.* 2022 (10 Oct);36:117. https://doi.org/10.47176/mjiri.36.117

Introduction

Pharmaceutical Research and development (R&D) are discovering, developing, and launching new pharmaceutical products. Industrial R&D is a scientific a nd economic process. The scientific sector identifies opportunities and limitations, but the economic sector determines which scientific opportunities and challenges are addressed

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↑What is "already known" in this topic:
R & D department plays a crucial role in the pharmaceutical industry product development.
The focus of previous studies was on the important factors and evaluation of R&D activities in pharmaceutical companies, which show various aspects and critical parameters in this area.

→What this article adds:
Regarding the importance of productivity in pharmaceutical industry R&D departments, in the present study, we find the elements that have significant effects on productivity.

As a result, we attempted to determine the most effective factors and to mention the ranking priority of each element affecting R & D unit Productivity.

through industrial research. The competitive position of leading pharmaceutical companies depends on R&D researchers and staff developing new products. Undoubtedly, in industry, there is a strong correlation between business success and the success of R&D researchers. Therefore, researchers and staff have been the main focus of the achievements of large pharmaceutical companies in the last 10-15 years (1, 2). The health sector is one of the most vital sectors of society, and pharmaceutical companies are one of the health sectors. In other words, pharmaceutical companies play an important role in maintaining and promoting public health, and the pharmaceutical industry plays a key role in providing the drugs society needs. R&D plays an important role in the pharmaceutical company's performance, and increasing the productivity of this vital institution can impact the drug market. Therefore, identifying the factors that increase the productivity of the R&D in pharmaceutical companies can significantly impact the pharmaceutical industry's success and the promotion of public health (3, 4).

The productivity term was first introduced by François Kane, a mathematician and economist. In 1883, another Frenchman, Liter, defined productivity as the science and technique of production. In 1950, the Organization for Economic Co-operation and Development (OECD) formally defined productivity as the fraction obtained by dividing the quantity or value of a product by the quantity or value of one of the factors of production (5, 6). The definition of productivity, according to the European Productivity Agency (EPA), is the ratio of returns to resources consumed. On the other hand, productivity is the ratio of goods or services produced to the resources used during production (7, 8). Productivity today is one of the most important factors in achieving the goals and progress of organizations. Attention to productivity is based on the belief that efficient staff can perform their tasks in the best form. When productivity is recognized as organizational culture, the organization, society, and country become a dynamic set in which every opportunity will be exploited for the benefit of the organization and the stuff (9).

One of the most important goals of managers of economic organizations and industrial production units is to improve and effectively use resources such as staff, budget, materials, energy, and information (10). The existence of an appropriate organizational structure, efficient executive methods, equipment and tools for healthy work, balanced work situations, and qualified staff are among the necessities that managers must consider to achieve optimal productivity (11, 12). Employees' participation in various matters, their consciousness and efforts, and work discipline can affect productivity, especially in a turbulent and insecure environment. Productivity improvement should be the most important scientists and staff objective (13).

Since productivity improvement is one of the most basic techniques to achieve more productivity and ensure individuals' well-being, recognizing the factors affecting productivity improvement has been one of the main ideas of researchers in this field (14). Various pieces of research consider the factors affecting the productivity of human resources, including work environment conditions, financial incentives, intangible motivational factors, etc., and recommend that managers use these factors to improve labor productivity. Productivity enhancement strategies require sufficient knowledge of the company's current situation and organizational culture. Due to the important differences in the organizational culture of companies and their current situation, it is predicted that strategies to increase productivity are also different from them (15). To our best knowledge, no study has been conducted on the factors affecting productivity promotion in the R&D of pharmaceutical companies. Productivity improvement is broad, but it can be measured by designing a questionnaire. Hence, this study aimed to identify and prioritize the effective factors for improving the productivity of the R&D Activities of Iranian pharmaceutical holding. The results of this study can provide a good basis for decision-making and policy-making of managers of pharmaceutical companies and pharmaceutical policy-makers in the country.

Methods

Study design

The present study was an empirical study done in 2020 at an Iranian pharmaceutical holding. In this study, a specified method was designed to determine and evaluate different variables and factors that affect a pharmaceutical company's productivity. The data used in this study was gathered from the questionnaire distributed to managers and employees of Iranian pharmaceutical holding.

The questionnaire was designed in two sectors; one evaluated the basic profile data of the interviewees, and the second tended to determine participants' attitudes according to nine factors in evaluating R&D activities. The four critical factors, including gender, age, education level, and work experience, were mentioned as the questionnaire's demographic profile data sector. Questions of the second sector were as follows management factors, socio-psychological factors, individual factors, cultural factors, environmental factors, economic factors, personal properties, education factors, equipment, and materials which chosen response could strongly disagree, disagree, no opinion, agree and strongly agree (Table 1). The main sampling targets were managers and employees of the R&D department.

Reliability and Validity of the questionnaire

One of the methods to calculate the reliability coefficient is Cronbach's alpha. This method is suitable for assessing the validity of a questionnaire designed as a Likert scale (9). In this research, Cronbach's alpha was calculated at 0.71. Validity was referred to how accurately a method measures what it is intended to measure. In other words, the extent to which a measuring instrument can measure the properties is considered the validity of the questionnaire. There are several methods for measuring validity, including content validity, face validity, and construct validity (16). In this paper, validity was measured by the content validity method that is not evaluated numerically and is individually evaluated by the researchers (17). Five people who qualified in the pharmaceutical field were

Table 1. Critical factors and questions

Factor dimension	Questions
Management factors	• Competence of the supervisor
	• The amount of work controlled by the manager
	• Timely and fair warning of supervisors about employees' mistakes
	• Continuous cooperation between different units of the organization
	• Investing in human resources
Socio-psychological factors	• A good relationship between manager and employee
	• Having job security
	• The feeling of fairness in work (non-discrimination, etc.)
	• Existence of a sincere atmosphere among employees
	• Participate in making a decision
Individual factors	• Equal career advancement opportunities
	• Having work experience
	• Existence of fit between individual interests and job
	• Level of Education
Cultural factors	• Having a work conscience and adhering to rules and regulations
	• Having a team working spirit
Environmental factors	• Ergonomics
	• Proper physical condition and safety at the workplace (light, noise, etc.)
Economic factors	• Proper payment of cash rewards
	• Proper payment of non-cash bonuses
	• Timely payment of salaries
Personal properties	• Be patient and calm
	• Helping colleagues when needed
	• Perform the job correctly the first time
Education factors	• Teaching teamwork
	• On-the-job training
Equipment and materials	• Changes in the quality of raw materials
	• Replacing equipment and machinery with workers
	• Use of new technologies

invited to participate in a pilot test to gauge the acceptance of the questionnaire. The participants suggested adding and omitting some parts of the questionnaire. Ultimately, all the qualified participants strongly agreed with the questionnaire's suitability. The questionnaire was considered finalized after modifying some of the questions.

Data collection

Data was gathered using a questionnaire distributed to 11 pharmaceutical companies affiliated with the Iranian pharmaceutical holding in Tehran, Iran. The questionnaires were sent to the R&D department to be filled by managers and employees. Accordingly, respondents from managers and employees who had comprehensive knowledge about the company's R&D activities were selected. The number of questionnaires sent out was 80; the number returned was 65, with a return rate of 81 percent.

Research hypothesis

In the present study, to determine the relationship between different factors which affect the productivity of the R&D department of Iranian Pharmaceutical Companies, the following hypotheses are proposed (Table 2).

Analysis of attitude survey

Descriptive analysis

The data collected by the questionnaire were summarized by the frequency distribution table and then displayed by graphs; subsequently, the data were analyzed using frequency, frequency percentage, mean, standard deviation, and variance (9).

Comparative and inferential analysis

The Kolmogorov–Smirnov (K-S) has been done to check the normality of the collected data. Also, the Pearson correlation coefficient was used to test the hypotheses. Afterward, the F test was used for regression significance. Insides, Friedman test was used to prioritize each factor affecting the productivity of the R & D department of pharmaceutical companies under the supervision of Irani-

Table 2. The different hypotheses of the present study

Hypothesis	Management factors
	• Socio-psychological factors
	• Individual factors
	• Cultural factors
	• Economic factors
	• Personal properties
	• Education
	• Equipment and materials
	• The significant difference between the factors

an pharmaceutical holding.

Results

Analysis of attitude survey

In the present study, data were collected using a self-administered questionnaire distributed to one big Iranian holding, including 11 pharmaceutical companies. Questions also included demographic profiles such as gender, age, education level, and work experience. As shown in Table 3, the sample size is 65, of which 43 are men and 22 are women. Among the subjects, people with 5 to 10 years of work experience had a higher frequency, and individuals with more than ten years of work experience had a lower frequency. It can be seen that people with doctorate education levels were frequent, and there were no people with an associate degrees. Also, people aged 35-40 years had a higher frequency, and those aged 25-30 years had a lower frequency.

According to Table 4, economic factors had a higher mean, and individual factors had a lower mean. Regarding the standard deviation, the dispersion of responses was the highest in the education factor and the lowest in economic factors compared to other factors. According to the values obtained from the K-S statistic in Table 3, it can be inferred that the expected distribution is not significantly different from the observed distribution for all variables. In other words, the distribution of these variables is normal.

Comparative and inferential analysis of research hypotheses

According to Figure 1, there is a significant difference between management, socio-psychological, individual, culture, environmental, economic, personality properties, education, and equipment and materials factors and productivity of R & D (p<0.05). Results show that by upgrading one unit of the independent variable to the coefficient of the independent variable, the dependent variable will increase. The t-statistic shows the relative importance of the independent variable.

The effect of each of the factors on the productivity of R & D was in the order of priority: economic factors, equipment and materials, environmental factors, management factors, educational factors, socio-psychological factors, cultural factors, personal properties, and individual factors (Table 5).

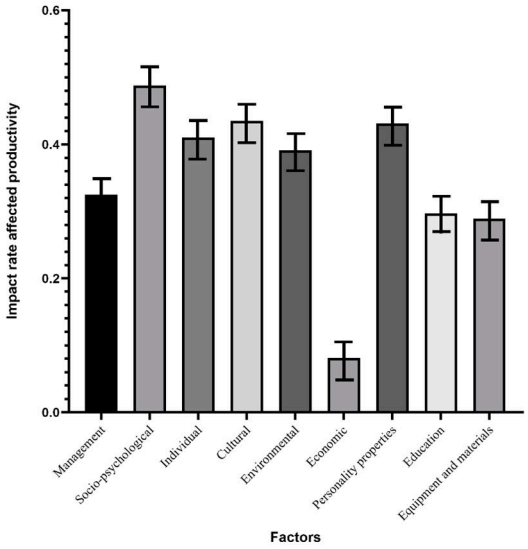

Fig. 1. The impact rate of different factors on the productivity of R&D.

According to Table 6, the highest average ranking of analyzed data related to investment in human resources was among management factors. On the other hand, the lowest average ranking was related to the timely and fair warning of the supervisors about the employees' mistakes. Also, the highest average ranking of data related to job security was among socio-psychological factors, and the lowest ranking of data was related to the existence of a sincere atmosphere among employees. The highest average ranking among individual factors was related to equal career advancement opportunities, and the lowest average was related to having work experience.

The highest data average was related to having a work

Table 3. Demographics of the respondents

Gender			Work experience			Education level			Age		
	Frequency	%		Frequency	%		Frequency	%		Frequency	%
Male	43	33.8	5 years>	18	27.7	Associate	0	0	25-30	3	4.6
Female	22	66.2	5-10 years	37	56.9	Bachelor	10	15.4	30-35	20	30.8
Missing	0	0	> 10 years	10	15.4	Master	15	23.1	35-40	29	44.6
Total	65	100	Total	65	100	Doctorates	40	61.5	40-45	13	20
						Total	65	100	Total	65	100

Table 4. Descriptive indicators of questionnaire factors

Variable	Mean	Std. Deviation	Variance	K-S statistic	*P*-value
Management factors	2.79	0.323	0.104	0.0350	0.212
Socio-psychological factors	2.455	0.358	0.128	0.362	0.181
Individual factors	2.146	0.426	0.181	0.381	0.165
Cultural factors	2.3	0.63	0.397	0.391	0.132
Environmental factors	2.992	0.64	0.409	0.393	0.128
Economic factors	3.743	0.269	0.072	0.476	0.105
Personality properties	2.353	0.536	0.288	0.346	0.219
Education factors	2.369	0.844	0.713	0.331	0.235
Equipment and materials	3.194	0.448	0.201	0.375	0.167

Table 5. Friedman test analysis

Factors	chi-square	df	*P*-value
Management factors	123.616	4	<0.001
Socio-psychological factors	148.34	4	<0.001
Individual factors	47.584	3	<0.001
Cultural factors	6.4	1	0.011
Environmental factors	23.113	1	<0.001
Economic factors	10.257	2	0.006
Personality properties	11.471	2	0.003
Education factors	23.12	1	<0.001
Equipment and materials	47.791	2	<0.001

Table 6. Propriety of different factors and variables

Factor dimension	Questions	Average ranking	Rank
Management factors	Investing in human resources	4.06	1
	Continuous cooperation between different units of the organization	3.78	2
	The amount of work controlled by the manager	3.29	3
	Competence of the supervisor	2.05	4
	Timely and fair warning of supervisors about employees' mistakes	1.82	5
Socio-psychological factors	Having job security	4.15	1
	A feeling of fairness in work (non-discrimination, etc.)	3.79	2
	Existence of a sincere atmosphere among employees	3.37	3
	Participate in making a decision	2.18	4
	A good relationship between manager and employee	1.52	5
Individual factors	Equal career advancement opportunities	2.95	1
	Existence of fit between individual interests and job	2.88	2
	Level of Education	2.51	3
	Having work experience	1.65	4
Cultural factors	Having a work conscience and adhering to rules and regulations	1.62	1
	Having a team working spirit	1.38	2
Environmental factors	Proper physical condition and safety at the workplace (light, noise, etc.)	1.77	1
	Ergonomics	1.23	2
Economic factors	Timely payment of salaries	2.13	1
	Proper payment of cash rewards	2.08	2
	Proper payment of non-cash bonuses	1.79	3
Personal properties	Helping colleagues when needed	2.15	1
	Be patient and calm	2.14	2
	Perform the job correctly the first time	1.71	3
Education factors	On-the-job training	1.76	1
	Teaching teamwork	1.24	2
Equipment and materials	Changes in the quality of raw materials	2.31	1
	Replacing equipment and machinery with workers	2.29	2
	Use of new technologies	1.40	3

conscience and adherence to rules and regulations, among cultural factors. On the inside, the lowest average ranking of the data was related to having a teamwork spirit. The highest average ranking of the data is related to the proper physical condition and safety at work (light, noise, etc.) among environmental factors, and the lowest ranking of the data was related to ergonomics. The highest average ranking of the data was related to the timely payment of salaries among economic factors. Furthermore, the lowest average ranking of the data was related to the proper payment of non-cash bonuses.

The highest average of the data was related to helping colleagues when needed among the personal properties. On the other hand, the lowest average ranking of the data was related to performing the job correctly the first time. The highest average ranking of the data was related to on-the-job training among educational factors, and the lowest average ranking of data is related to teaching teamwork. The highest average of the data was related to the change in the quality of raw materials among equipment and raw materials. The lowest average of data is related to the use of new technologies.

Discussion

The technology transfer in developing new pharmaceutical products is necessary and undeniable. Therefore, the improvement of quality assurance systems of pharmaceutical products in all stages of R&D of production and marketing in line with the process of reviewing the current quality assurance laws and methods of their implementation is considered. The ultimate goal in the successful technology transfer is to provide documentary evidence of the adequacy of the raw material manufacturing processes and the final product in quality products and their compliance with the recorded specifications. In the pharmaceutical industry, technology transfer means transferring technology and information necessary to achieve quality products during the manufacturing process. Achieving better productivity and efficiency in each department depends on the adequacy, capability, and productivity of the human resources of that department.

Productivity improvement is broad, but it can be measured by designing a questionnaire. Hence, this study aimed to identify and prioritize the effective factors for improving the productivity of the R&D Activities of Ira-

nian pharmaceutical holding. The most important management factor affecting productivity was investing in human resources. A different study on the effect of the participatory leadership style of managers, human resources components, and performance appraisal on employee productivity followed this hypothesis and confirmed this study's results (18, 19). Then, according to the results of this study and other studies, it seems that management factors include: the competence of the supervisor, the amount of work controlled by the manager, timely and fair warning of supervisors about employees' mistakes, continuous cooperation between different units of the organization, and investment in human resource has an impact on increasing the productivity of the research and development sector.

According to the results of this study and other studies, socio-psychological factors include: good relations between manager and employee, having job security, a feeling of fairness at work (non-discrimination, etc.), the existence of a sincere atmosphere between employees, and participation in decision-making were effective on increasing the productivity of R&D department (9, 20). According to the Friedman test, which was conducted among the components of socio-psychological factors, it was observed that having job security had the greatest impact on productivity. Other aspects of feeling of fairness of work (non-discrimination, etc.), a good relationship between manager and employee, participation in decision-making, and an intimate atmosphere among employees have affected productivity, respectively.

According to the results of this study and other studies, individual factors, including equal career advancement opportunities, have had the greatest impact on productivity. Also, the fit between individual interests and jobs, education level, and work experience have affected productivity, respectively (21). Annabi et al. showed the effect of having a team-working spirit on products, consistent with this study's result (18). The results also showed that having a work conscience and adherence to rules and regulations had the greatest impact on productivity. Having a team-working spirit also impacted productivity. Gerge et al. indicated the effect of the appropriate environment on productivity (20). Therefore, according to the results of this study and other studies, it could be considered appropriate physical conditions and safety of the workplace have had the greatest impact on productivity, and then ergonomics has affected productivity.

Timely payment of salaries has had the greatest impact on productivity. In addition, proper payment of cash and non-cash rewards have increased the productivity of R&D, respectively (20, 22). Studies have shown that employees' abilities affect productivity. The results of this study show that helping colleagues when needed has the greatest impact on productivity; patience, calmness, and proper execution of work are personality traits that have affected productivity, respectively (23). On-the-job training has had the greatest impact on productivity, followed by teamwork training. Researchers have confirmed that continuing education can affect the productivity of the R&D department (20, 22).

Furthermore, changes in the quality of raw materials, the replacement of equipment and machinery with workers, and new technologies have impacted productivity significantly. Another study confirmed raw material factors' effect on the productivity of the R&D department, which was under the results of this study (20). There was a significant difference between the components affecting the productivity of the R&D department in terms of priority. The most impact was related to economic factors, and the least was related to individual factors.

Conclusion

Our results showed that economic factors were recognized as the most important and individual factors as the least important factors. Furthermore, human resources affected productivity in Iranian pharmaceutical companies.

Acknowledgments

Thanks Iran University of Medical Sciences, we had an opportunity to complete this study.

Conflict of Interests

The authors declare that they have no competing interests.

References

1. Jones O. Strategic HRM: The implications for pharmaceutical R&D. Technovation. 1996;16(1):21-32.
2. Maher JA. Development and Implementation Strategies for Open Innovation Pharmaceutical R&D Projects: Walden University; 2021.
3. Khaledi A, Meskini M. A systematic review of the effects of Satureja khuzestanica Jamzad and Zataria multiflora Boiss against Pseudomonas aeruginosa. Iran J Med Sci. 2020;45(2):83.
4. Brooks K, Nafukho FM. Human resource development, social capital, emotional intelligence: any link to productivity? J Eur Ind Train. 2006;30(2):117-28.
5. Moghaddam ZD, Jafari M. Investigating Occupational and Organizational Factors Affecting The Productivity of Clinical Staff In A Hospital. Trends Life Sci. 2014;3(5):153-7.
6. Askari R, Seyed Rezaei ZS, Mahdiyan S, Pishehvaran M. Investigation of the Relationship between Organizational Citizenship Behavior and Human Resources Productivity: Based on the Staff Viewpoints in the Selected Hospitals of Yazd City, 2018. Evid Based Health Policy Manag Econ. 2020;4(1):57-63.
7. Manual F. Guidelines for collecting and reporting data on research and experimental development. URL: http://www oecd org/sti/frascati-manual-2015-9789264239012-en htm. 2015.
8. Meskini M, Ghorbani M, Bahadoran H, Esmaeili D. ZOUSH ointment with the properties of antibacterial moreover, burn wound healing. Int J Pept Res Ther. 2020;26(1):349-55.
9. Rasekh HR, Mehralian G, Vatankhah-Mohammadabadi AA. Situation analysis of R & D activities: an empirical study in Iranian pharmaceutical companies. Iran J Med Sci. 2012;11(4):1013.
10. Kim E, Lee I, Kim H, Shin K. Factors Affecting Outbound Open Innovation Performance in Bio-Pharmaceutical Industry-Focus on Out-Licensing Deals. Sustainability. 2021;13(8):4122.
11. Boldeanu DM, Pugna IB. The analysis of the influence factors affecting the performance of pharmaceutical companies. J Theor Appl Eng. 2014;21(7).
12. Meskini M, Rami MR, Maroofi P, Ghosh S, Siadat SD, Sheikhpour M. An overview on the epidemiology and immunology of COVID-19. J Infect Public Health.2021;14(10):1284-98.
13. Herdman G. Pharmaceutical R and D: Costs, Risks, and Rewards. Washington DC: DIANE Publishing; 1993.
14. Scannell JW, Blanckley A, Boldon H, Warrington B. Diagnosing the decline in pharmaceutical R&D efficiency. Nat Rev Drug Discov. 2012;11(3):191-200.

15. Schuhmacher A, Wilisch L, Kuss M, Kandelbauer A, Hinder M, Gassmann O. R&D efficiency of leading pharmaceutical companies–A 20-year analysis. Drug Discov Today. 2021;26(8):1784-9.
16. Berg BL, Lune H. Qualitative research methods for the social sciences. Pearson Publishing; 2012.
17. Kaplan RM. Basic statistics for the behavioral sciences: Allyn & Bacon; 1987.
18. Annabi M, Kebriaeezadeh A, Marashi-Shoshtari S, Ghodsi S. Priority setting for productivity indices in Iranian Pharmaceutical Companies Introduction. J Pharmacoecon Pharma Manag. 2015;1(1/2):27-31.
19. Mehralian G, Rasekh H, Yousefi M. New Product Development in the Pharmaceutical Industry: Evidence from Iran. Iran J Pharm Res. 2017;16(2):831-43.
20. Gerges M, Austin S, Mayouf M, Ahiakwo O, Jaeger M, Saad A, et al. An investigation into the implementation of Building Information Modeling in the Middle East. ITcon. 2017;22:1-15.
21. Grant K, Matousek R, Meyer M, Tzeremes NG. Research and development spending and technical efficiency: evidence from biotechnology and pharmaceutical sector. Int J Prod Res. 2020;58(20):6170-84.
22. Blocher E, Chen K, Li T. Cost management: A strategic emphasis (ed.): New York, NY: McGraw Hill International; 2002.
23. Light DW, Lexchin JR. Pharmaceutical research and development: what do we get for all that money? BMJ. 2012;345.