

ИССЛЕДОВАНИЕ ВЛИЯНИЯ ПРИМЕНЕНИЯ ИННОВАЦИЙ И ИНФОРМАЦИОННЫХ И КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ НА ПРОИЗВОДИТЕЛЬНОСТЬ ИТ-КОМПАНИЙ

*Дарвиши Захра*¹

¹ Университет имени Шахида Бехешти, Тегеран, Иран

АННОТАЦИЯ

Настоящее исследование посвящено оценке влияния инноваций и применения информационных и коммуникационных технологий на производительность ИТ-компаний с использованием методов искусственного интеллекта. Данная работа носит прикладной характер. Использовались методы нейронной классификации и кластеризации для изучения возможности классификации компаний на основе их уровня эффективности. Статистическую совокупность составили компании Тегерана (Иран) в сфере информационных технологий и разработки программного обеспечения (всего 767 компаний). Используя метод простой случайной выборки и формулу Кронбаха, было отобрано 263 директора или заместителя этих компаний и проведено их анкетирование. Результаты этого исследования показали: при интеллектуальном анализе данных с помощью метода нейронной классификации точность классификации компаний составила 91,4%; при интеллектуальном анализе данных с помощью метода нейронной кластеризации соответствие модели составляло 62,6%. В итоге был сделан вывод о том, что применение инноваций и информационных и коммуникационных технологий существенно влияет на производительность компаний в сфере информационных технологий.

Ключевые слова: научно-техническая политика, применение инноваций, информационные и коммуникационные технологии, искусственный интеллект.

INVESTIGATING THE EFFECTS OF APPLYING INNOVATION AND INFORMATION AND COMMUNICATION TECHNOLOGY ON IT COMPANIES' PERFORMANCE

*Darvishi Zahra*¹

¹ Shahid Beheshti University, Tehran, Iran

ABSTRACT

The present study was conducted to understand the impacts of innovation and information and communication technology application via artificial intelligence on the performance of information technology companies. The article was based on an applied objective. Neural classification and neural clustering techniques were utilized to examine the feasibility of classifying companies based on their performance level. Information Technology-Software companies in Tehran (767 active companies) comprised the statistical population. Using a simple random sampling method and the Cronbach's formula, the number of 263 directors or deputies of these companies (estimating the attrition level in questionnaires) constituted the statistical samples. The findings of this study suggested that; (1) in data-mining via neural classification method, the model fit in the model learning section was equal to 91.4%, and (2) in data-mining via neural clustering method, model fit was 62.6%. The findings concluded that the application of innovation and information and communication technology significantly affect the performance of information technology companies.

Keywords: science and technology policy, application of innovation, information and communication technology, artificial intelligence.

Introduction

Information technology has been increasingly growing in recent years and is widely applied in daily business activities. Organizational performance benefits from employing information technology. Researchers have shown that information technology can promote organizational efficiency and performance (Feng Yang, 2018).

To promote quality and utilization, such components as efficiency and fairness should also be

taken into account. To achieve better organizational performance, an effective director is required [1]. Moreover, information and communication technology (ICT) affect organizational performance [2]. Information and communication technology (ICT) has a positive and direct impact on performance. If employees in an organization fail to adopt information and communication technology, or it is not used optimally, it will engender a failed performance of the organization and on the other

hand, resulting in a lower performance of the organization [3].

Meanwhile, to explain the performance of companies, especially IT companies with a high level of complexity whose market performance is affected by various measures, one needs to fully explain the factors affecting their performance. It is seen that two basic principles, i.e., the application of innovation and the application of information and communication technology (ICT), play a major role in the performance of these companies. Accordingly, the main question raised here is: Can we employ new analytical methods such as artificial intelligence to classify information technology companies (based on the application of innovation and of information and communication technology (ICT)?

Conceptual Research Model

According to the theoretical and experimental basics, the theoretical-conceptual model of this research is plotted as according to Figure 1.

Research method

The present study falls under observational research in terms of objective and is considered to be a descriptive study. Information Technology-Software companies in Tehran (767 active companies) comprised the statistical population (767 companies active in software production out of 2161 information technology companies). Using a simple random sampling method and Cronbach's formula to determine the sample size, the number of 263 directors or deputies of these companies was selected. This study employed questionnaires to collect data on directors' and deputies' views to understand the state of research variables. Thus, the number of 300 questionnaires was given out to consider the attrition

level, with 263 ones finally accepted and analyzed. In this study, the field method was used to collect data on responses given to the items.

In the meantime, MATLAB software was used to run the neural network clustering algorithm to group the companies. Modeling software and structural equations were used to determine the effects of variables on corporate performance, using SMART. PLS software; meanwhile, when their significant effects were determined, fit values were considered when running the neural network clustering algorithm [4].

Findings

Table 1 summarizes the results from measures of central tendency and measures of dispersion as well as minimum and maximum data for the research variables.

Data mining results by Classification method

The present study includes ten inputs (7 information and communication technology variables and 3 company innovation variables) and one output (three levels of the performance level of companies). As regards the output, companies have been ranked low, moderate, and high in terms of performance levels. Before this, the data recorded for input variables (ICT and company innovation variables) were classified into their relevant groups. The companies scoring 1 to 2.5 were designated as the innovation and information and communication technology companies with low performance (first group); the companies scoring 2.5 to 3.5 as the ones with moderate performance (second group); the companies scoring 3.5 to 5 were found to generate a good performance (third group). Thus, the artificial neural network structure based on classification or pattern recognition was determined in this section.

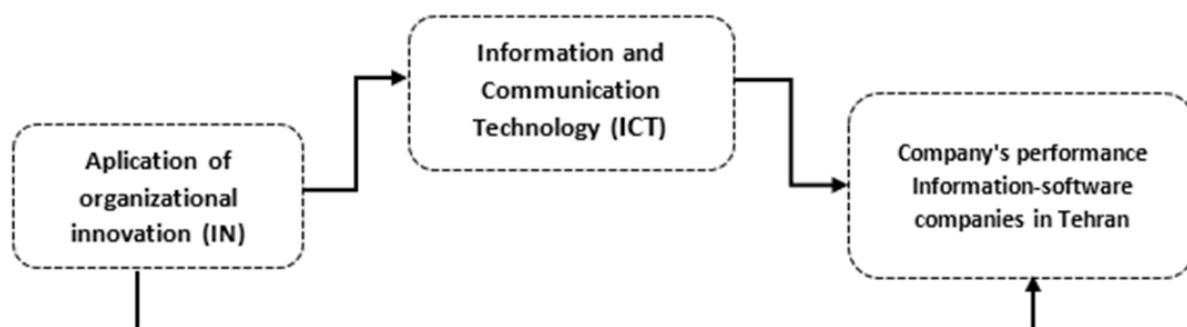


Figure 1 – Conceptual model of research

Table 1 – Descriptive analysis of research variables (n = 263)

	Mean	SD	Min.	Max.
[1] Individual characteristics	3.786	0.943	1.5	5.0
[2] Attitudinal factors	3.571	0.989	1.6	4.9
[3] Educational factors	3.663	1.009	1.7	5.0
[4] Technical factors	3.663	1.114	1.2	5.0
[5] Economic (costs) factors	3.744	1.021	1.6	5.0
[6] Environmental factors	3.720	1.136	1.0	5.0
[7] Human and managerial factors	3.818	0.912	1.6	5.0
Information and Communication Technology (ICT)	3.710	0.945	1.5	4.9
[1] Innovative technology in the product	3.626	1.142	1.3	5.0
[2] Innovative technology in the process	3.744	1.129	1.0	5.0
[3] Innovative technology in the market	3.496	1.176	1.0	5.0
Company innovation	3.532	1.056	1.1	5.0
Company performance	3.555	1.185	1.0	5.0

Figure 2 illustrates 17 cases of artificial intelligence training. In other words, the input data to the artificial neural network were reviewed up to 17 times. Based on this training, an estimation of the classification of companies' performance level by data mining method (of classification type) is as follows (Figure 2).

Four types of artificial neural network performance for data mining were provided for

the neural classification section, which consisted of training performance, evaluation performance, test performance, and overall performance. In this study, code 1 pertains to the first group, i.e., companies with a good performance level; code 2 to the second group as the ones with average performance, and finally, code 3 to the third group, i.e., the ones with poor performance level. An examination of the general diagram (bottom

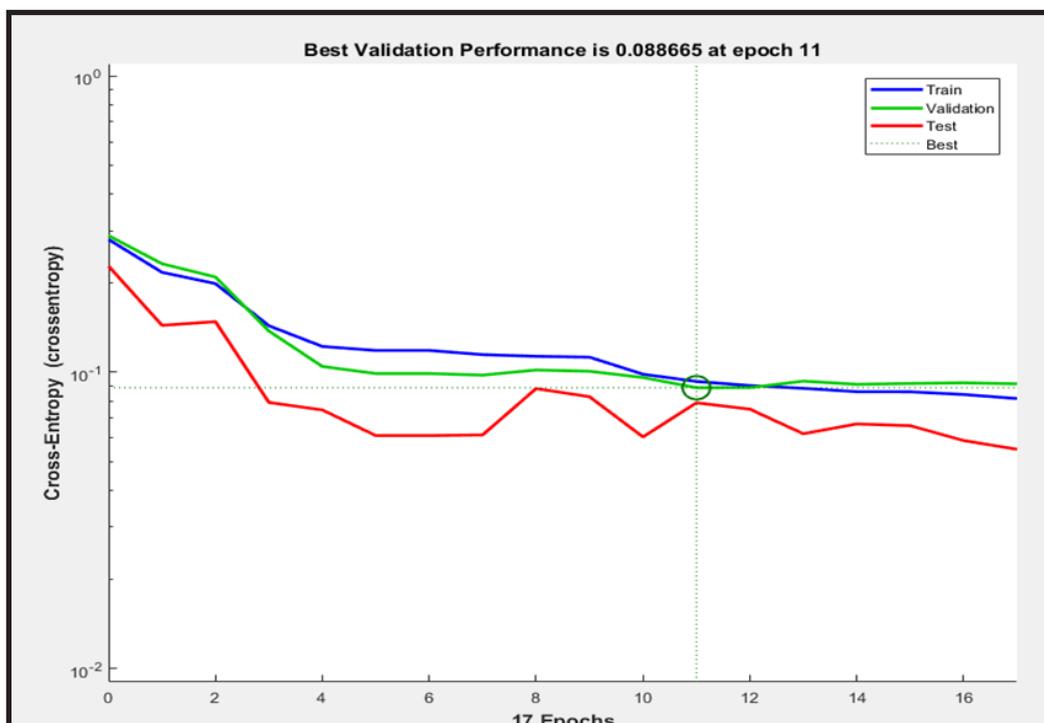


Figure 2 – Performance of artificial intelligence learning repetition (pattern recognition)

on the right side of Figure 3) reveals that data mining based on artificial neural networks and neural classification methods (pattern recognition) can classify 91.4% of the companies quite correctly. The findings demonstrate that 94.8% of the companies enjoying good performance had been correctly classified. In the second group, namely, the companies with an average performance, the number of correct responses amounted to 65.4%; however, as regards companies with poor performance, 94.2% of the samples had correctly been estimated (in total, the estimation power in the data mining method was 91.4%).

Data mining results by neural clustering method

As Figure 4 shows, the number of 100 neurons was used to classify and cluster the companies. These 100 hexagonal neurons are interrelated to six other neurons, with the performance level of each affecting the latter.

As Figure 5 illustrates, the neurons, at the bottom right of the image, were able to create a line of neurons that distinguishes companies with low, moderate, and high-performance levels (as shown in Figure 20, there are three main clusters as 146 items

fall in the three main clusters, out of 233 samples available. Accordingly, the model fit was 62.6% in this section).

Discussion and Conclusion

The findings of the present study were notable in two sections. The findings implied that using information and communication technology, especially its subscales can help classify companies by data mining method as they are ranked based on their level of performance. In yet another section, the relationships between these variables were put to test and confirmed in the present study, for which modeling methods were employed. The findings in this section were found to be consistent with those reported in the study done by Bernard et al. [5], as their study suggested that companies' performance was affected by information and communication technology components.

Speaking of companies' innovation and performance, two issues should be raised: First, the data mining employed in the present study demonstrates that company innovation can be regarded as an important factor in classifying

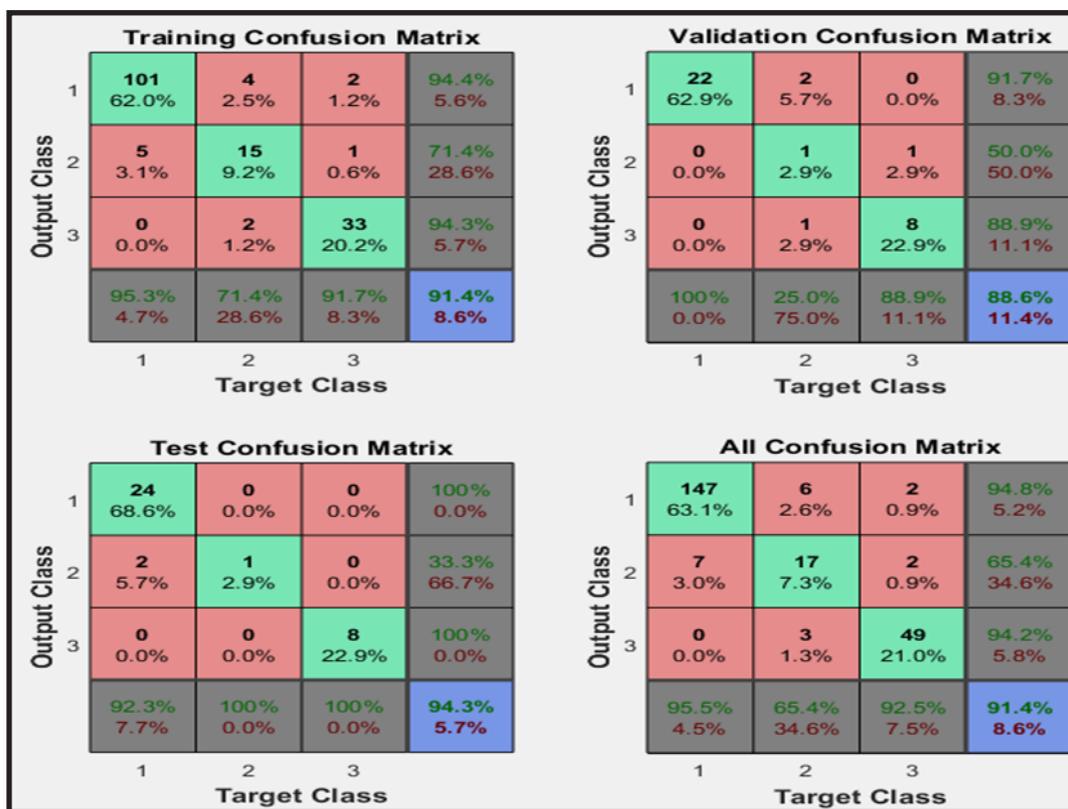


Figure 3 – Identification of companies with good, poor, and average performance levels by neural classification method

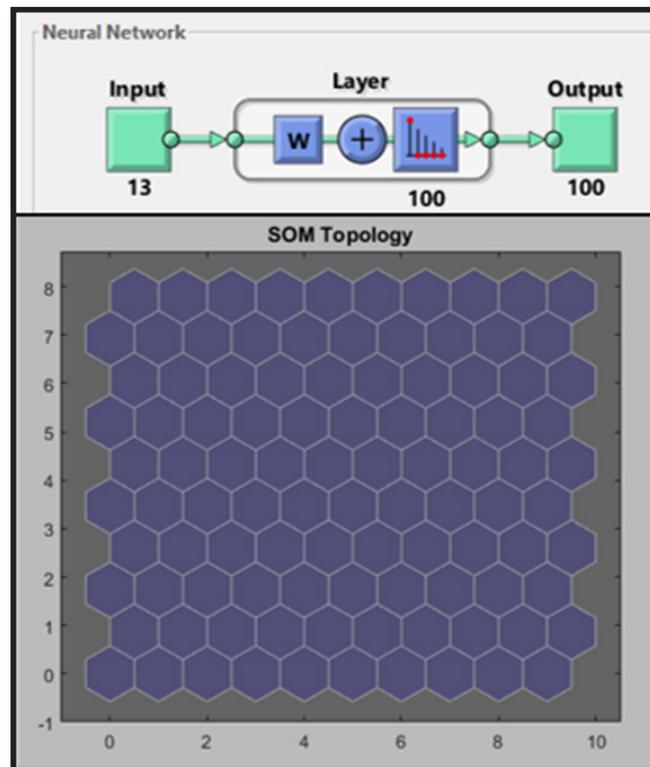


Figure 4 – Artificial neural network topology by neural clustering

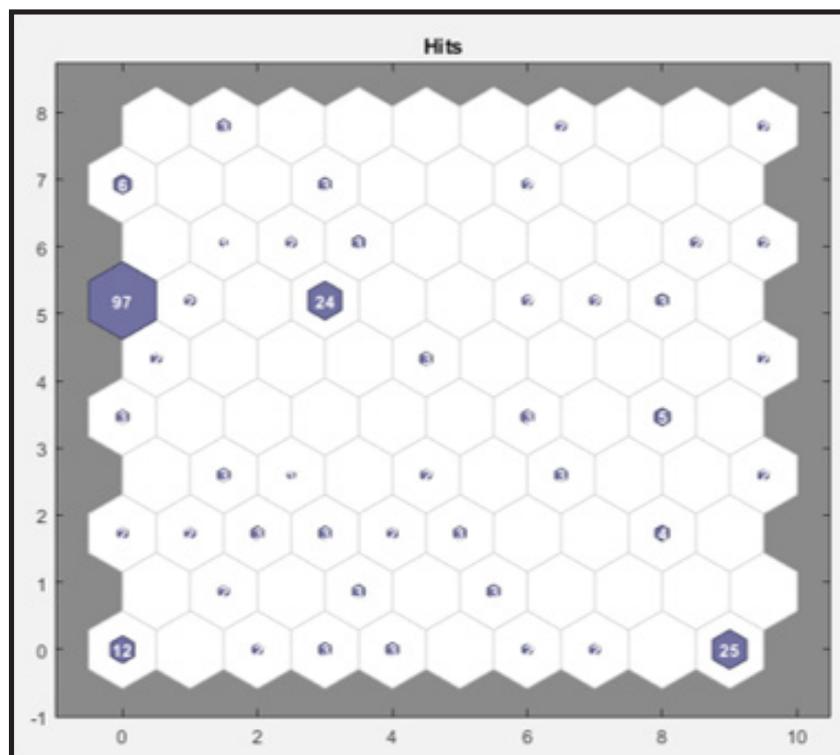


Figure 5 – Classification of samples in each of the neurons (clusters)

companies based on their performance. On the other hand, disregard the effects both variables of information and communication technology characteristics and company innovation may have on the corporate performance, one can show that the two

components are interactive and overlap each other. To sum up, considering the findings of the present study, one would argue that company innovation affects the performance of IT companies. Here, the findings matched those of the study by Bernard et al. [5].

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Сведения об авторах:

ДАРВИШИ ЗАХРА – *департамент науки и технологической политики, Университет имени Шахида Бехешти, Тегеран, Иран*

Authors' information

DARVISHI ZAHRA – *M.A. of Science and Technology Policy, Shahid Beheshti University, Tehran, Iran*