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A study on the effect of business process reengineering on the information technology management improvement in knowledge-based IT organizations

Shima Nargesi, Ghassem Ali Bazaee*

Department of Information Technology Management, Central Tehran Branch, Islamic Azad University, Tehran, Iran

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Abstract

The present study aimed to investigate the effect of business process reengineering on information technology management improvement in knowledge-based IT organizations according to statistical analysis methodology in SPSS. The statistical population consisted of two general groups, first, knowledgeable professors, and second, ITIL experts, or similar positions in knowledge-based IT organizations. After distributing 100 questionnaires, the sample size of the research was equal to 96 available and cooperative experts who were collected by a combination of two methods, namely non-probability purposive (judgmental) sampling, and snowball sampling, in the spring of 2019. According to the important result of the study "Investigating the Effect of business process Reengineering on the promotion of ITM", since the slope of the regression line was the correlation coefficient sign, there was a positive significant relationship between IT design process reengineering ($X2$) and IT transfer process reengineering ($X3$) variables because the statistical correlation coefficient between them was calculated to be 0.913, and there was a statistical correlation coefficient of 0.778 between the IT strategy process reengineering ($X1$) and continuous IT improvement process reengineering ($X5$), and a correlation coefficient of 0.836 between the IT design process reengineering ($X2$) and the IT strategy process reengineering ($X1$), and the correlation coefficient equal to 0.838 between the IT operation process reengineering ($X4$), and IT transfer processes reengineering ($X3$). The impact of business process reengineering on IT management improvement can be comprehensively evaluated due to the high correlation between research variables and indices.

Keywords: Business Process Reengineering (BPR), Information Technology Management (ITM), knowledge-based IT organizations, statistical analysis methodology, SPSS
2020 MSC: 62L10, 68V30

1 Introduction

Business process reengineering (BPR) is a concept of effective organizational strategy in the industrial sectors with the emergence of liberalization, privatization, and globalization of the economy [36]. An important reason for differentiating organizations is the degree to which they use information technology (IT) in organizational activities.

*Corresponding author
Email addresses: Shi.Nargesi.mng@iauctb.ac.ir (Shima Nargesi), Bazaee.Ali@gmail.com (Ghassem Ali Bazaee)

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Information technologies are new management tools that help organizations achieve their organizational goals. However, many organizations and businesses still do not show successful performance in this field [2, 5]. A reason for the high rate of failure in strategic planning of organizations is paying too much attention to one factor and not paying full attention to other organizational factors. Accordingly, assessing the organization's readiness for strategic alignment should be considered a starting point for comprehensive information technology projects [41]. In any today's organization, the speed and accuracy of the business processes are the main goals of management because they lead to the satisfaction of stakeholders, and ultimately the business success. To achieve it, the use of the business reengineering system is a new and practical option [5, 29]. Business process reengineering is a management approach with a focus on the alignment of all aspects of an organization with customer needs and demands. Ensuring business readiness is the basic precondition for establishing business process reengineering [31].

Furthermore, the development and use of electronic services play an important role in the development of information technology applications. The way of using such services to be effective has always been considered by service planners and developers [2]. Given the importance of information technology, the Business-IT alignment using information and technology is an important factor in the success of achieving business goals, in other words, there is a need for good information technology governance to achieve effective use of information technology in businesses. There are several studies on organizational governance, but no research has been conducted on the appropriate information technology governance [21]. Due to the development of information and communication technology and its entry into the world work environment, there has been a close relationship between the use of IT in organizations and performance improvement, as well as better and faster achievement of organizational goals. Therefore, the comprehensive information and communication technology plan, as a dynamic plan, utilizes the IT resources of the organization such as infrastructures, information resources and systems of human resources, and financial resources to support and advance the long-term and short-term goals of the organization. Business-IT alignment was then expressed as a framework for implementing business policies, processes, and internal controls to effectively support all services provided by IT groups [15]. Effective IT governance enables the organization to achieve three critical goals, namely compliance with the rules, and regulations of operational excellence, and optimal risk management and can help the organization to ensure that goals are supported by IT, IT investment is improved, and IT-related risks and opportunities are managed [33]. To spend the least possible cost and provide the best quality is the biggest challenge for IT service businesses. This can be seen in different sectors of organizations, such as increasing the human resource productivity, optimal use of existing capacities, and creating new facilities and capacities in accordance with the real needs of the organization [7, 32]. Having advanced technology and specialized manpower alone is not the solution, and there is a very important issue, called service management procedures, or information technology service, which is the link between technology and people. The ITIL framework has emerged as a key challenge for Business-IT alignment, and organizations are strongly seeking to establish an ITIL framework to improve IT customer relations and better meet the organization's expectations. Constant changes in IT infrastructure have led to higher complexity, and if not properly managed, they threaten service continuity.

The problems of this research included the complexity and ambiguity of decision-makers and managers of knowledge-based IT organizations due to a combination of different methods of analyzing IT service strategy process reengineering, IT service design process reengineering, IT service transfer process reengineering, IT service operation process reengineering, and Continuous IT service process reengineering to improve the information technology management in knowledge-based IT organizations. It is expressed as the need to use statistical analysis methodology to increase trust and confidence in decision-making, as well as the need for multiple expertise through the simultaneous use of information from experts in various fields to solve these problems.

2 Literature review

Business process reengineering (BPR) is a method for complete improvement in performance by utilizing resources in a way that the maximum added value is obtained in business activities [6, 23]. Costly activities of processes or the whole organization are minimized in reengineering [22]. Processes are the most basic and effective organizational components [15]. To have the desired effectiveness and efficiency and provide the basis for value creation, and development and creation of competitive advantages, organizations need process architecture to achieve improved processes [29, 49]. Business process management is the most advanced type of management that helps organizations to improve their efficiency. Business process management is a method for developed countries to improve business. To enjoy the benefits of business process management implementation in knowledge-based organizations, we should focus on the factors affecting the success of this system [15]. Expert senior managers in various organizations are well aware that the design and control of organizations from a process perspective are necessary and inevitable [2]. Furthermore, they know that investigating and measuring performance and efficiency is a prelude to analyzing and improving business processes. This issue has been considered an important issue in business process management (BPM) [6, 23]. However, measurement criteria alone are important issues that have been investigated by various studies worldwide [2]. The key to "business success" for many organizations is the right use of processes to make better, faster, and flawless decisions. To achieve this goal, organizations need to use powerful and efficient tools such as organizational intelligence as a positive catalyst that can help them mechanize the tasks of analysis, decision-making, strategy formulation, and prediction [9, 51]. "The business processes improvement" is a process in which the current tasks of the organization are replaced by the main processes; hence, the organization moves from a duty-oriented to a process-oriented state [6, 23]. This will accelerate the business process, reduce costs, and thus make the business more competitive. Implementing reengineering projects, like other projects, faces several risks and dangers [24, 28]. Some of these risks are rooted in the nature of business process reengineering and can be seen in any organization and project [20, 39] but other risks may arise based on the culture of the business or the country where the reengineering is performed [18]. Every goal-based technology business, which has an active and coordinated system and is connected to the external environment, is a social institution. In the past, most organizations were content with gradual changes to take advantage of opportunities, but over time, it became clear that gradual changes alone do not solve the current problems of organizations, and sometimes the survival of the organization is dependent on fundamental changes [18]. These revolutionary changes are known as "business process improvement" [17, 29, 49]. Organizations are facing rapid change, and an organization can survive if it has the necessary mechanisms to face changes in the current competitive environment. The process-oriented approach and process-based management are approaches that help the survival of organizations in today's competitive environment [25, 26]. Processes are the cores of organizations. In the past, organizations provided separate systems for each process within that process, known as island systems, but because of the impossibility of connecting these systems and designing systems for only one separate sector, the whole organizational goals were not satisfactorily met; hence, integrated organizational systems emerged [5]. In the comprehensive approach, a system consists of several subsystems that are reengineered to be related to each other, but the problem is the large load of designing and implementing systems. The business process reengineering is then proposed, which with multiple models required by organizations, provides an integrated method for defining, implementing, reviewing, and reengineering business processes, minimizes workload, and facilitates management by utilizing relevant methods and tools. [9, 43, 48].

The conceptual model of the research is a model that demonstrates the reality of evaluating the use of business process reengineering to improve IT management in knowledge-based IT organizations and describes and illustrates certain aspects of the real world in the organizational IT industry related to examining issues and reveals important relationships between different aspects of the variables that affect the of Business-IT alignment. The principle of information richness is a logical criterion for stopping the preparation of a conceptual research model, in other words, the researcher takes into account the considerations, research facilities, and time, and collects theoretical information in the field of variables affecting the improvement of Business-IT alignment and examines internal or external sources as far as the collecting information is repeated and the vicious cycle begins. After conducting studies on variables affecting the improvement of Business-IT alignment, the most important variables and indices affecting the improvement of Business-IT alignment as a theoretical framework of the research are presented in the following figure:

After investigating the theoretical bases of the research and literature review, it was found that conducting this research to prevent problems in knowledge-based IT organizations in the field of IT service process reengineering, IT service design process reengineering, IT service transfer process reengineering, IT service operation process reengineering, and continuous IT service improvement process reengineering to improve IT management in IT knowledge-based organizations, and also lack of a model to provide advice to the manager to decide on the impact of business process reengineering on IT management improvement in knowledge-based IT organizations can help the innovation of the present research to solve the research gaps.

3 Research methodology

Since the interactive nature of research as "the examination of the effect of business process reengineering on the improvement of information technology management" requires a dialogue between the researcher and experts, the researcher's misconceptions were converted to awareness. The research had a descriptive-modeling method in terms of the purpose to help make decisions because on the one hand, it accurately described the concepts related to the impact of business process reengineering in improving information technology management, and on the other hand, the experts in the field of effects of business process reengineering on improving IT management evaluated and determined the relationship between the concepts. The term "expert" means having information in a field, the ability to understand the problem in that field, and the skill information used to solve such problems [4]. An important reason for researchers to use statistical analysis (SPSS) is the ability to test theories in the form of correlations between variables. Another reason is the consideration of measurement error by this method which allows the researchers to report their information analysis by taking into account the measurement error [4, 34].

A- Statistical population and research sample

The research population consisted of two general groups, first, knowledgeable professors (academic experts), and second, ITIL experts working in knowledge-based IT organizations (industry experts). The sampling method was a combination of two methods, namely non-probability purposive (judgmental) sampling, and snowball sampling. Given the nature of the sampling method, the sample size of the research was equal to experts who were available and willing to cooperate.

B- Data collection tools, method of confirming the research reliability and validity

Internet access, research on studies, books, articles in domestic and foreign journals, and statistics and documents published by the university were used due to the use of articles and documents related to the effect of business process reengineering in improving information technology management from various sources for desk studies. For field studies, the researcher-made tools were used to collect research data, interview ITIL experts, and university professors. The need for observation and interview was also a prerequisite for evaluating the research. Due to the use of articles and documents related to providing a model to investigate the impact of business process reengineering on the improvement of information technology management from various sources, the data collection method of the study was the “case study of documents”; hence, the components of the decision-making and interview models were used to evaluate the impact of business process reengineering on the improvement of information technology management that was extracted from the expert opinions. The seven-point Likert scale was used as the most common measurement scale to design a tool for the localization of the research components in the present study. For research validity in the present study, the questionnaire was prepared based on theoretical sources, articles, and texts related to the subject and was approved by experts. Using Cronbach’s alpha coefficient at the beginning and end of the distribution, the reliability of the questionnaire was ensured. In other words, the validity and reliability were the two main criteria for testing the accuracy and goodness of the measures [4, 34].

C- Data analysis method and research software

Statistical analysis was used to answer questions or test hypotheses. Furthermore, descriptive and inferential statistics were used to analyze data obtained from the tools for localization of research components. Furthermore, the effects of business process reengineering on the improvement of information technology management were investigated using useful statistical methods and SPSS as a widely-used and useful research software. The statistical package for social science (SPSS) is a special statistical software package that performs statistical analysis and estimation of the relationship between research variables in humanities and sociology studies [4, 34]. A relatively high level of statistical complexity is necessary to use SPSS effectively [4, 34]. The steps of statistical analysis to investigate the effect of business process reengineering on the improvement of information technology management are as follows:

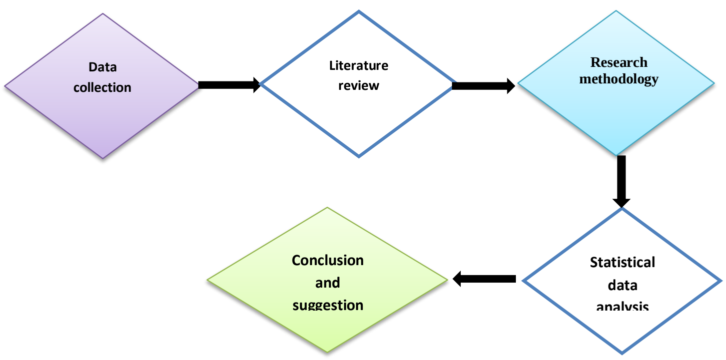

Diagram 1: Steps of research implementation

The structure of the present manuscript is as follows: The first section includes the generalities of the manuscript. The chapter for literature review presents a history of research and articles about the research subject. The third section is dedicated to research methodology, and the fourth section presents data analysis. The fifth section summarizes and investigates the model and provides conclusions and suggestions for future research.

Definition

The most familiar measure of dependence between two qualities is the Pearson product-moment correlation coefficient (PPMCC) or "Pearson's correlation coefficient", commonly called simply "the correlation coefficient". It is obtained by taking the ratio of the covariance of the two variables in question of our numerical dataset, normalized to the square root of their variances. Mathematically, one simply divides the covariance of the two variables by the product of their standard deviations. Karl Pearson developed the coefficient from a similar but slightly different idea by Francis Galton. A Pearson product-moment correlation coefficient attempts to establish a line of best fit through a dataset of two variables by essentially laying out the expected values and the resulting Pearson's correlation coefficient indicates how far away the actual dataset is from the expected values. Depending on the sign of our Pearson's correlation coefficient, we can end up with either a negative or positive correlation if there is any sort of relationship between the variables of our data set.
The population correlation coefficient $\rho_{X,Y}$ between two random variables X and Y with expected values μ_X and μ_Y and standard deviations σ_X and σ_Y is defined as:

$$\rho_{X,Y} = \operatorname{corr}(X,Y) = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$$

where E is the expected value operator, cov means covariance and corr is a widely used alternative notation for the correlation coefficient. The Pearson correlation is defined only if both standard deviations are finite and positive. An alternative formula purely in terms of moments is:

$$\rho_{X,Y} = \frac{E(XY) - E(X)E(Y)}{\sqrt{E(X^2) - E(X)^2} \cdot \sqrt{E(Y^2) - E(Y)^2}}$$

Symmetry property

The correlation coefficient symmetric: $\operatorname{corr}(X,Y) = \operatorname{corr}(Y,X)$. This is verified by the commutative property of multiplication.

Correlation as product

Let random variables X and Y have standard deviations $\sigma_X > 0$ and $\sigma_Y > 0$. Then:

$$\operatorname{corr}(X,Y) = \operatorname{corr}\big(X, E(X|Y)\big) \operatorname{corr}\big(E(X|Y), Y\big)$$

Correlation and independence

It is a corollary of the Cauchy-Schwarz inequality that the absolute value of the Pearson correlation coefficient is not bigger than 1. Therefore, the value of a correlation coefficient rangers between -1 and $+1$. The correlation coefficient is $+1$ in the case of a perfect direct (increasing) linear relationship (correlation), -1 in the case of a perfect inverse (decreasing) linear relationship (**anti-correlation**) and some value in the open interval $(-1, 1)$ in all other cases, indicating the degree of linear dependence between the variables. As it approaches zero there is less of a relationship (closer to uncorrelated). The closer the coefficient is to either -1 or 1, the stronger the correlation between the variables.
If the variables are independent. Pearson's correlation coefficient is 0, but the converse is not true because the correlation coefficient detects only linear dependencies between two variables.

$$X, Y \text{ independent} \Rightarrow \rho_{X,Y} = 0 \quad (X, Y \text{ uncorrelated})$$
$$\rho_{X,Y} = 0 \quad (X, Y \text{ uncorrelated}) \nRightarrow X, Y \text{ independent}$$

For example, suppose the random variable X is symmetrically distributed about zero, and $Y = X^2$. Then Y is completely determined by X, so that X and Y are perfectly dependent, but their correlation is zero; they are uncorrelated. However, in the special case when X and Y are jointly normal, uncorrelatedness is equivalent to independence.

Even though uncorrelated data does not necessarily imply independence, one can check if random variables and independent if their mutual information is 0.

Sample correlation coefficient

Given a series of n measurements of the pair (X_i, Y_i) indexed by $i = 1, \ldots, n$, the *sample correlation coefficient* can be used to estimate the population Pearson correlation $\rho_{X,Y}$ between X and Y. The sample correlation coefficient is defined as

$$r_{xy} \stackrel{\text{def}}{=} \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}},$$

where $\bar{x}$ and $\bar{y}$ are the sample means of X and Y and s_x and s_y are the corrected sample standard deviations of X and Y.
Equivalent expressions for r_{xy} are

$$\begin{aligned} r_{xy} &= \frac{\sum x_i y_i - n\bar{x}\bar{y}}{n s'_x s'_y} \\ &= \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\sqrt{n\sum y_i^2 - (\sum y_i)^2}}. \end{aligned}$$

where s'_x and s'_y are the *uncorrected* samples standard deviations of X and Y.
If x and y are results of measurements that contain measurement error, the realistic limits on the correlation coefficient and not -1 to $+1$ but a smaller range. For the case of a linear model with a single independent variable, the coefficient of determination (R squared) is the square of r_{xy}. Pearson's product-moment coefficient.

4 Data analysis

The research population consisted of two general groups, first, experts, and second, decision-makers, and experts working in the field of Business-IT alignment or similar positions. After distributing 100 questionnaires, the sample size was equal to 96 available and cooperative individuals who were selected by a combination of non-probability purposive (judgmental) sampling and snowball sampling. Data were collected about measurement tool 1 (modeling tool for using Business-IT alignment) in the spring of 2019 and data about measurement tool 2 (validation tool for "Decision system for Business-IT alignment") in the late spring of 2019. The following table briefly describes the demographic characteristics of the research sample in terms of gender, education degree, and relevant work experience.

Table 1: A summary of the demographic description of the research sample

Row	**Type of characteristic**	**Characteristics**	**Number**	**Relative frequency (%)**
1	Gender	Male	75	78%
		Female	21	22%
2	Education degree	Bachelor	36	38%
		Master	51	53%
		Ph.D.	9	9%
3	Related work experience	3-5 years	18	19%
		6-10 years	66	68%
		More than 10 years	12	13%

Scientific documents, research standards, as well as the opinions of supervisors, advisors, and some decision-makers and experts were used to examine the extent to which the measurement tool of the research assessed the desired characteristics, and the tool for determining the variables of the initial decision model reached its final form after the application of their opinions.

The mean, standard deviation, and correlation were utilized to statistically describe the research data. The following table presents the descriptive information of research variables and indices based on the number of data,

Table 2: Descriptive information about decision-making based on the ideal importance of research variables

Research indices and variables	**Number of data**	**Minimum**	**Maximum**	**Mean**	**Sd**
IT strategy process reengineering (X1)	96	5	7	5.47	0.632
Financial management process of business	92	4	7	5.65	0.791
Service portfolio management process of business	96	5	7	5.63	0.757
Service management demand process of business	96	3	7	5.68	1.000
Relation management process of business	96	5	7	5.80	0.803
Strategic service management process of business	96	5	7	5.91	0.884
IT design process reengineering ($X2$)	96	5	7	5.79	0.854
Service catalog management process of business	96	3	7	5.51	0.833
Service level management process of business	96	3	7	5.67	1.012
Service capacity management process of business	92	4	7	5.93	0.899
Service availability management process of business	96	5	7	5.92	0.867
Service provider management process of business	96	3	7	5.77	1.041
IT transfer process reengineering ($X3$)	96	5	7	5.73	0.827
Service transfer planning and supporting the process of business	96	5	7	5.91	0.884
Service change management process of business	92	5	7	5.95	0.830
Service configuration and asset management process of business	96	3	7	5.51	0.929
Service test and confirmation process of business	96	4	7	5.62	0.785
Service knowledge management process of business	96	3	7	5.66	0.993
IT operation process reengineering ($X4$)	96	5	7	5.56	0.678
Service event management process of business	96	5	7	5.67	0.804
Service incident management process of business	96	3	7	5.83	1.053
Service problem management process of business	96	3	7	5.68	1.000
Service desk process of business	96	5	7	5.76	0.818
Service request process of business	96	3	7	5.59	0.969
Continuous IT improvement process reengineering (X5)	96	5	7	5.73	0.840
IT service improvement to serve customers faster	96	3	7	5.52	0.894
IT service improvement to establish customer relationships	96	3	7	5.51	0.929
IT service improvement to increase productivity	96	5	7	5.64	0.769
IT service improvement to reduce organizational costs	96	5	7	5.91	0.884
IT service improvement to improve flexibility and scalability	96	5	7	5.91	0.834

minimum, maximum, mean, and standard deviation, indicating that the data were in a proper status in terms of symmetry and accumulation.

Based on the professional opinions and experience of managers, decision-makers, and senior experts of knowledge-based organizations in Tehran, as well as the opinions of university professors, the most important criteria for the “IT strategy process reengineering ($X1$)” were as follows: The relation management process of business with an average of 5.80, and the strategic service management process of business with an average of 5.91. The most important criteria for “IT design process reengineering ($X2$)” were as follows: the service capacity management process of business with an average of 5.93, and the service availability management process of business with an average of 5.92. The most important criteria for “IT transfer process reengineering ($X3$)” were as follows: the service transfer planning and supporting process of business with an average of 5.91, and the service change management process of business with an average of 5.95. The most important criteria for the “IT operation process reengineering ($X4$)” were as follows: Service incident management process of business with an average of 5.83, and service desk process of business with an average of 5.76. The most important criteria for “continuous IT improvement process reengineering ($X5$)” were as follows: IT service improvement to reduce organizational costs with an average of 5.91, and IT service improvement to improve flexibility and scalability with an average of 5.91. On the other hand, ranking the research variables based on the weighted average of the ideal importance of their indices was as follows: IT design process reengineering with a weighted average of 5.765, and IT transfer process reengineering with a weighted average of 5.730, continuous IT improvement process reengineering with a weighted average of 5.703, IT strategy process reengineering with a weighted average of 5.690, and the IT operation process reengineering with a weighted average of 5.682, while the research variables based on the weighted average of the performance status of their indices were as follows: IT transfer process reengineering with the weighted situational average equal to 4.903, and IT strategy process reengineering with a weighted average of 4.752, continuous IT improvement process reengineering with a weighted average of 4.683, IT operation process reengineering with a weighted average of 4.577, and IT strategy process reengineering with a weighted average of 4.562. Based on descriptive information about the variables of the impact of business process reengineering on the improvement of information technology management, the weighted average of the performance status of research variables should paid special attention to their decisions. The main reason for analyzing the reliability

Table 3: Descriptive information about decision-making based on the functional status of research variables

Research indices and variables	Number of data	Minimum	Maximum	Mean	Sd
IT strategy process reengineering (X1)	92	1	6	4.90	1.548
Financial management process of business	96	1	6	4.21	1.406
Service portfolio management process of business	96	1	6	4.66	1.493
Service management demand process of business	92	1	6	4.59	1.535
Relation management process of business	96	2	6	4.76	1.263
Strategic service management process of business	96	1	6	4.25	1.353
IT design process reengineering ($X2$)	96	1	6	5.05	1.109
Service catalog management process of business	94	1	6	4.61	1.483
Service level management process of business	92	3	6	4.79	1.172
Service capacity management process of business	96	1	6	4.48	1.679
Service availability management process of business	94	1	6	4.67	1.213
Service provider management process of business	96	1	6	4.91	1.274
IT transfer process reengineering ($X3$)	90	4	6	5.31	0.593
Service transfer planning and supporting process of business	96	3	6	5.01	0.814
Service change management process of business	94	1	6	4.76	1.309
Service configuration and asset management process of business	92	1	6	4.90	1.006
Service test and confirmation process of business	92	3	6	4.52	1.084
Service knowledge management process of business	96	2	6	4.95	1.173
IT operation process reengineering ($X4$)	92	3	6	4.95	1.123
Service event management process of business	92	1	6	4.39	1.497
Service incident management process of business	96	1	6	4.42	1.412
Service problem management process of business	96	1	6	4.58	1.574
Service desk process of business	92	1	6	4.30	1.642
Service request process of business	96	2	6	4.82	1.095
Continuous IT improvement process reengineering (X5)	96	1	6	4.63	1.481
IT service improvement to serve customers faster	96	1	6	4.76	1.185
IT service improvement to establish customer relationships	94	1	6	4.61	1.553
IT service improvement to increase productivity	92	1	6	4.46	1.253
IT service improvement to reduce organizational costs	96	1	6	4.76	1.382
IT service improvement to improve flexibility and scalability	94	1	6	4.88	0.982

of the data collection tool of the research is to what extent the measurement tool gives the same results under the same conditions, and to what extent the correlation between one set of answers and another set of answers is in an equivalent test that is independently on the subject group. The table about reliability statistics of research variables according to the number of items of measurement tools shows the high reliability of the measurement tools in this research.

Table 4: Information about the reliability statistics of research variables

Research variables	Cronbach's alpha	Number of items
IT strategy process reengineering ($X1$)	0.916	6
IT design process reengineering ($X2$)	0.909	6
IT transfer process reengineering ($X3$)	0.924	6
IT operation process reengineering ($X4$)	0.863	6
Continuous IT improvement process reengineering ($X5$)	0.926	6
Overall reliability of research variables	0.983	30

The average Cronbach's alpha for the research variables is greater than 0.9, indicating that the reliability of the modeling tool using Business-IT alignment is in excellent status. Given the parametric nature of statistical tests in the present study, the Pearson correlation coefficient based on the research variables is used to investigate the effectiveness and impressibility between the function variable (dependent) and independent variables.

As presented in the table above for the correlation between research variables, since the correlation coefficient sign is the slope of the regression line and due to the high correlation between research variables and indices, the effect of business process reengineering on IT management improvement can be comprehensively evaluated.

Table 5: Correlation between research variables

Correlation between research variables		IT strategy process reengineering ($X1$)	IT design process reengineering ($X2$)	IT transfer process reengineering ($X3$)	IT operation process reengineering ($X4$)	Continuous IT improvement process reengineering ($X5$)
IT strategy process reengineering ($X1$)	Statistical correlation	1	0.836	0.790	0.755	0.778
	Sig.		0.000	0.000	0.000	0.000
	Number of data	96	96	96	96	96
IT strategy process reengineering ($X2$)	Statistical correlation	0.836	1	0.913	0.758	0.721
	Sig.	0.000		0.000	0.000	0.000
	Number of data	96	96	96	96	96
IT transfer process reengineering ($X3$)	Statistical correlation	0.790	0.913	1	0.838	0.621
	Sig.	0.000	0.000		0.000	0.000
	Number of data	96	96	96	96	96
IT operation process reengineering ($X4$)	Statistical correlation	0.755	0.758	0.838	1	0.737
	Sig.	0.000	0.000	0.000		0.000
	Number of data	96	96	96	96	96
Continuous IT improvement process reengineering ($X5$)	Statistical correlation	0.778	0.721	0.621	0.437	1
	Sig.	0.000	0.000	0.000	0.000	
	Number of data	96	96	96	96	96

5 Discussion and conclusion

An important result of the present study titled "A study on the effect of business process reengineering on the improvement of IT management using statistical analysis methodology" was that there was a positive and very significant relationship between variables of IT strategy process reengineering ($X1$) and IT operation process reengineering ($X4$) for Business-IT alignment because the statistical correlation coefficient between them was calculated to be 0.755. Furthermore, there was a positive and significant relationship between variables of IT design process reengineering ($X2$) and IT transfer process reengineering ($X3$) because the statistical correlation coefficient between them was calculated to be 0.913. There was a positive and very significant relationship between variables of IT operation process reengineering ($X4$) and IT design process reengineering ($X2$) because the statistical correlation coefficient between them was equal to0.758. There was a positive and significant relationship between variables of IT strategy process reengineering ($X1$) and continuous IT improvement process reengineering ($X5$) because the statistical correlation coefficient between them was equal to 0.778. Moreover, there was a positive and significant relationship between variables of IT design process reengineering ($X2$) and IT strategy process reengineering ($X1$) because the statistical correlation coefficient between them was equal to 0.836. There was a positive and significant relationship between variables of IT operation process reengineering ($X4$) and IT transfer process reengineering ($X3$) because the statistical correlation coefficient between them was calculated to be 0.838. Furthermore, there was a positive and significant relationship between variables of the continuous IT improvement process reengineering ($X5$) and IT transfer process reengineering ($X3$) for Business-IT alignment because the statistical correlation coefficient between them was equal to 0.621 because according to the Recognition act of knowledge-based organizations and institutions, knowledge-based organizations are private or cooperative institutions economic development is made based on knowledge and achievement of scientific and economic goals to increase science and wealth and promote invention and innovation, and finally, commercialize research and development results (including the design and production of goods and services) in the field of top technologies with high value-added (especially in the production of related software).

An advantage of using a case study in research is that it is a systematic way of reviewing events, collecting data, analyzing data, and reporting results to examine the effect of business process reengineering on the improvement of information technology management in knowledge-based IT organizations because such organizations basically do not produce goods and generally do not have specific land or machinery. Rather, there are always some educated and experienced individuals who produce information as the main product of the organization and it generates income for them. Industrial projects and the intellectual properties of products have been always main concerns of organizations. Maintaining the intellectual properties of this information is an important legal issue in knowledge-based organizations because these assets are intangible.

References

[1] C. Alaceva and L. Rusu, *Barriers in achieving business/IT alignment in a large Swedish company: What we have learned?*, Comput. Human Behav. **51** (2015), 715–728.

[2] M. Alimoradi, S.M.A. Khatami-Firouzabadi and H. Javanshir, *A study on research background in business process performance (BPP) using data envelopment analysis (DEA)*, First Int. Conf. Manag. Educ. Soc. Psych. Sci. Manag. Horizon of Iran 2025, Mashhad, 2019.

[3] A. Al-Surmi, G. Cao and Y. Duan, *The impact of aligning business, IT, and marketing strategies on firm performance*, Ind. Market. Manag. **84** (2020), 39–49.

[4] A. Azar and M. Momeni, *Statistics and its application in management. Volumes I and II: Statistical Analysis*, The Organization for Researching and Composing University Textbooks in the Humanities (SAMT), 2009.

[5] H. Azimi, A. Morshedi and D. Abbasi, *The roles of business learning and business process on the knowledge-based performance of businesses (Research sample: Zanjan Finance Department, and Bojnurd Industry and Mining Business)*, Quart. J. Strategic Bus. Knowledge Manag. **3** (2020), no. 9.

[6] M. Bagherfar and F. Eskandar, *A Study on the role of process reengineering in improving the structure of knowledge-based IT companies*, Second Int. Conf. Manag. Account. Econ. Sustain. Dev. Kamravash Knowledge-Based Cooperative Institute, Mashhad, 2018.

[7] A. Behboudi and S. Sohrabi, *Alignment of business strategies with knowledge management strategies*, Bus. Manag. Quart. **12** (2020), no. 45.

[8] P. Bhattacharya, *Aligning enterprise systems capabilities with business strategy: An extension of the strategic alignment model (SAM) using enterprise architecture*, Procedia Comput. Sci. **138** (2018), 655–662.

[9] F.J. Brandl, K.S. Ridolfi and G. Reinhart, *Can we adopt the Toyota Kata for the (re-) design of business processes in the complex environment of a manufacturing company?*, Procedia CIRP **93** (2020), 838–843.

[10] A. Cater-Steel, M. Toleman and W.-G. Tan, *Transforming IT service management-the ITIL impact*, Proc. 17th Aust. Conf. Inf. Syst., 2006.

[11] P. Centobelli, R. Cerchione and E. Esposito, *Aligning enterprise knowledge and knowledge management systems to improve efficiency and effectiveness performance: A three-dimensional Fuzzy-based decision support system*, Expert Syst. Appl.**91** (2018), 107–126.

[12] M. Chi, R. Huang and J.F. George, *Collaboration in the demand-driven supply chain: Based on a perspective of governance and IT-business strategic alignment*, Int. J. Inf. Manag. **52** (2020), Article 102062.

[13] N.J. Cruz-Hinojosa and J. A. Gutiérrez-de-Mesa, *Literature review of the situation research faces in the application of ITIL in Small and Medium Enterprises*, Comput. Stand. Interfaces **48** (2016), 124–138.

[14] C. dos Santos Garcia, A. Meincheim, E.R.F. Junior, M.R. Dallagassa, D.M.V. Sato, D.R. Carvalho, E.A.P. Santos

and E.E. Scalabrin, *Process mining techniques and applications- A systematic mapping study*, Expert Syst. Appl. **133** (2019), no. 1, 260–295.

[15] M. Ghazanfari, H. Mardi and E. Hassan Naebi, *The analysis of key success factors of business process management systems with Gray DEMATEL Model: A case study in Zanjan Municipality*, Sixth Int. Conf. Ind. Syst. Engin. (ICISE), Mashhad, 2020.

[16] K. Hinkelmann, A. Gerber, D. Karagiannis, B. Thoenssen, A. Van der Merwe and R. Woitsch, *A new paradigm for the continuous alignment of business and IT: Combining enterprise architecture modeling and enterprise ontology*, Comput. Ind. **79** (2016), 77–86.

[17] L. Hosseini, *A study on the impact of electronic business processes on commercial value (Case study: Saipa Business)*, First Nat. Conf. Res. Dev. Manag. Resist. Econ. Research Institute of Culture and Arts (Research and Development Institute), Tehran, 2018.

[18] S. Hosseinnia and E. Marefatpour, *The relationship between influence and risk matrix with the success of reengineering projects. electronic welfare service process improvement project of the Ministry of Welfare and Social Security*, 10th Int. Conf. Econ. Manag. Islamic Azad University of Rasht, Rasht, 2017.

[19] I. Kawtar, D. Karim and B. Salah, *Proposal model of change for Business IT alignment*, Procedia Comput. Sci. **164** (2019), 96–104.

[20] S. Keshavarz, M. Ghavidel, K. Sahraeian and S. Taheri, *A study on the relationship between information and communication technology perception and business performance with the mediating role of supply chain management and business process reengineering in Shiraz Industrial Town*, 2nd Int. Conf. New Dev. Manag. Econ. Account. Allameh Khoei Institute of Higher Education, Koush International Business, Tehran, 2018.

[21] S. Keshavarzzadeh and B. Abdi, *The architectural model of good IT Governance based on Zachman framework for enterprise architecture*, First Int. Conf. New Parad. Bus. Intell. Manag. Shahid Beheshti University, Tehran, 2016.

[22] M. Khoon Siavash and M. Mohammadi, *A Study on the challenges of implementing BPR (business process reengineering) in knowledge-based IT companies in Iran*, J. Dev. Manag. **1** (2009), no. 2, 65–73.

[23] A. Khoshnoud and Z. Labadi, *Identification and Prioritization of Determinants in Implementing Process Reengineering in Strategic Planning of Tehran Education Department*, Third Conf. Soc. Empowerment Humanities Psych. Stud. The Center for Empowerment of Cultural and Social Skills of the Society, Tehran, 2018.

[24] H. Kir and N. Erdogan, *A knowledge-intensive adaptive business process management framework*, Inf. Syst. **95** (2021), 101639.

[25] D. Knoll and R. Gunther,*Enabling value stream mapping for internal logistics using multidimensional process mining*, Expert Syst. Appl. **124** (2019), no. 15, 130–142.

[26] D. Knoll, J. Waldmann and G. Reinhart, *Developing an internal logistics ontology for process mining*, Procedia CIRP **79** (2019), 427–432.

[27] M. Kowalczyk and P. Buxmann, *An ambidextrous perspective on business intelligence and analytics support in decision processes: Insights from a multiple case study*, Decis. Support Syst. **80** (2015), 1–13.

[28] R.D. Leon, R. Rodríguez-Rodríguez, P. Gómez-Gasquet and J. Mula, *Business process improvement and the knowledge flows that cross a private online social network: An insurance supply chain case*, Inf. Process. Manag. **57** (2020), no. 4, 102237

[29] L. Liu, W. Li, N.R. Aljohani, M.D. Lytras, S.U. Hassan and R. Nawaz, *A framework to evaluate the interoperability of information systems – Measuring the maturity of the business process alignment*, Int. J. Inf. Manag. **54** (2020), 102153.

[30] P. Malta and R.D. Sousa, *Process oriented approaches in enterprise architecture for business-IT alignment*, Procedia Comput. Sci. **100** (2016), 888–893.

[31] H. Moalemi, H. Salami and S. Nejati, *Pathology of key success factors in establishing business reengineering systems based on the importance performance analysis (Case study: Fars Gas Business)*, First Int. Conf. Manag. Tools Techniq. Narkish Information Institute, Tehran, 2014.

[32] A. Moradi, *A Study on the effect of strategic alignment of information technology and business on business performance of sustainable communication industries*, Int. Conf. Interdiscip. Stud. Manag. Engin. Tehran, 2019.

[33] N. Modiri and Z. Ebadi, *The roles of governance components and IT alignment to evaluate the performance of business IT*, First Region. Conf. New Approach. Comput. Engin. Inf. Technol. Islamic Azad University of Rudsar and Amlash, Rudsar, 2011.

[34] M. Momeni and A. Faal-Ghayoumi, *Statistical analyses using SPSS*, In Persian, Ketabeno Pub., 2016.

[35] A. Ordonez, H. Ordonez, J.C. Corrales, C. Cobos, L.K. Wives and L.H. Thom, *Grouping of business processes models based on an incremental clustering algorithm using fuzzy similarity and multimodal search*, Expert Sys. Appl. **67** (2017), 163–177.

[36] S. Pattanayak and S. Roy, *Synergizing business process reengineering with enterprise resource planning system in capital goods industry*, Procedia Soc. Behav. Sci. **189** (2015), no. 15, 471–487.

[37] F.M. Pérez, J.V.B. Martinez and I.L. Fonseca, *Strategic IT alignment projects. Towards good governance*, Comput. Stand. Interfaces **76** (2021), 103514.

[38] C. Pollard and A. Cater-Steel, *Justifications, strategies, and critical success factors in successful ITIL implementations in US and Australian companies: an exploratory study*, Inf. Syst. Manag. **26** (2009), no. 2, 164–175.

[39] M. Pourhadadi, *Development towards an Accounting Based on Business Processes*, Fifth Nat. Conf. Appl. Res. Manag. Account. Tehran, Iran, 2018.

[40] S. Pourmirza, S. Peters, R. Dijkman and P. Grefen, *A systematic literature review on the architecture of business process management systems*, Inf. Syst. **66** (2017), 43–58.

[41] F. Rashedi, *A study on the alignment of information technology strategy and business strategy*, First Int. Conf. New Parad. Commerc. Bus. Intell. Manag. Shahid Beheshti University, Tehran, 2016.

[42] E. Rojas, M. Sepúlveda, J. Munoz-Gama and D. Capurro, *Question-driven methodology for analyzing emergency room processes using process mining*, Appl. Sci. **7** (2017), no. 3, 302.

[43] H. Safarzadeh and M. Ghoreyshi, *The role of using the business process reengineering system in improving the business performance*, 2010.

[44] E.A.A. Seman and J. Salim, *A model for business-IT alignment in Malaysian Public Universities*, Procedia Technol. **11** (2013), 1135–1141.

[45] Z. Shao, *Interaction effect of strategic leadership behaviors and organizational culture on IS-Business strategic alignment and enterprise systems assimilation*, Int. J. Inf. Manag. **44** (2019), 96–108.

[46] Y.W. Si, V.I. Chan, M. Dumas and D. Zhang, *A Petri net-based generic genetic algorithm framework for resource optimization in business processes*, Simul. Model. Pract. Theory **86** (2018), 72–101.

[47] N. Tax, X. Lu and N. Sidorova, D Fahland *The imprecisions of precision measures in process mining - Short communication*, Inf. Process. Lett. **135** (2018), 1–8.

[48] S. Teixeira, B.A. Agrizzi, J.G. Pereira Filho, S. Rossetto and R. de Lima Baldam, *Modeling and automatic code generation for Wireless Sensor Network Applications using Model-Driven or Business Process approaches: A systematic mapping study*, J. Syst. Software **132** (2017), 50–71.

[49] A. Van Looy, *A quantitative and qualitative study of the link between business process management and digital innovation*, Inf. Manag. **58** (2021), no. 2, 103413.

[50] J. Wang and Lazar Rusu, *Factors hindering business-IT alignment in small and medium enterprises in China*, Procedia Comput. Sci. **138** (2018), 425–432.

[51] B. Zarei and S. Farkish, *A Study on Reengineering Experiences in Iran*, Fourth In. Conf. Ind. Engin. Iran, 2010.