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Assessing Business-IT Alignment Maturity and Application Architecture Components in Companies with Enterprise Architecture Implementation (Case Study: Mobile Telecommunication Company of Iran)

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Abstract
A comprehensive program acts as an integrated force among various business aspects, such as objectives, organizational structure, processes, data, automation aspects and hardware program. This study aimed to examine the business-IT alignment through the alignment between the components of enterprise architecture. Business-IT effective alignment requires analyzing the business problems and changes at all levels. The business -IT interface must be based on transparent and consistent business requirements and information; in fact, business related solutions should interact with IT solutions (Consurtium, 2001). This article tried to examine the business-IT alignment through the alignment between the components of enterprise architecture.

Keywords: IT, business, strategic alignment, IT-business alignment, enterprise architecture, enterprise architecture framework

1. Introduction

Today, the need to develop the quality of industrial, commercial, scientific, political and even cultural and art organizations based on systematic principles, techniques and planning is no secret, and all organizations, institutions and agencies try to improve, develop and increase their productivity through optimal management.
According to reports, information systems-business alignment accounts for about 52% of information systems executives' concerns, and information systems alignment is introduced as the second most important factor in the success of organizations (CIISM, 2001).
In this type of architecture, the main attention is given to the layers of the enterprise architecture. These layers are, in fact, the four main components of enterprise architecture which can be seen in all enterprise architecture frameworks. This research focuses on how business and IT are aligned as expressed in the enterprise architecture concepts and components.

1.1. Definition of technical terms

Information technology: IT is a new concept with a complicated history and has its root in the 1950s business computers which appeared over time in the 1980s information systems and literally in the 21st century (Aurora Sanchez Ortiz, 2003).
IT refers to any use of technology for data processing, storage, collection, distribution and transmission. IT studies, designs, implements, supports and manages computer information systems, and uses computers and software programs to convert, store, protect, process, transmit and secure information (ITAA).

Business: "Business is legally introduced as the organization's program to support the production of goods or the provision of services to customers." (www.wikipaidia.com)

Strategic alignment: alignment sometimes means balance, coordination, integration, alliance, composition, integrity and compliance. Alignment is the adjustment of an object in relation to another object, or is the fixed orientations between two objects (www.Wikipedia.com).
In various articles, the alignment has been given different names, such as: balance, consistency, coordination, integration, coherence and connection (Amini Motlagh, 2009), and fusion (Samakzani, 2001).

Business-IT alignment: today, alignment is one of the main challenges for organizations, because they cannot compete without it. The effect of investment in IT on organizational performance is clear for researchers and executives. In fact, business-IT alignment, over the past 20 years, is considered one of the 5 priorities for management systems (Palvia, & Whitworth, 2002; Pick, & Ward, 2000; Gottschalk, 2001).
Enterprise architecture: the experience of other fields of science and engineering tells us that wherever there is a need to manage or design such a complicated entity or system, or if specific requirements are required, it will need a particular and comprehensive attitude called "architecture" (Fereydoun Shams, 2009).

- "The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution" (Standard IEEE, 147).
- A base information source which explains the structure of mission and information required by the organization, and technologies needed to support them, and defines the transition process to implement these technologies (O'Rourke et.al. 2003).

What is enterprise architecture?
Zachman defined "enterprise architecture" as follows:

- A set of descriptive representations (models) which explains an organization so that it can be in accordance with the management requirements (quality), and can be maintainable in the course of its useful life (Zachman, J, 1987).

- The transitional processes required for implementing new technologies in response to changing needs, including a baseline architecture, a target architecture and a sequencing plan (US E-Government Act, 2002).

What is an enterprise architecture framework?

In general, a "framework" is a tool for classifying objects. Since our theme is related to the organization, the target objects are also descriptions of aspects and areas of the organization. For any organization, there are at least two frameworks: A) a framework of basic models that describes the "current status" of the organization, and is called the existing architecture framework. B) Another framework which determines the "future state" (after applying enterprise architecture) is called the target architecture framework (Ardavan Majidi, 2009).

The enterprise architecture (EA) framework is a conceptual framework for describing the business architecture, IT and the alignment of the two in an organization. In fact, the EA framework is a documentation structure of the EA (Wieringa, R, 2004).

1.2. Zachman Framework

The Zachman architecture framework, a kind of Mendeleev's table of architecture models, is a reference framework covering six aspects of information, processes, places, people, events and objectives. The Zachman framework plays a key role in the development of other frameworks, such as the "Federal Architecture Framework". John Zachman, a pioneer of "enterprise architecture" who is today considered as the father of this science, considers the EA as the unavoidable necessity for large organizations (Zachman, J, 1987).

Although the Zachman framework is somehow old today, and does not meet today's needs, it is not yet considered as a reference and source for the EA. The Zachman architecture framework has had a direct effect on most of next frameworks and architecture concepts.

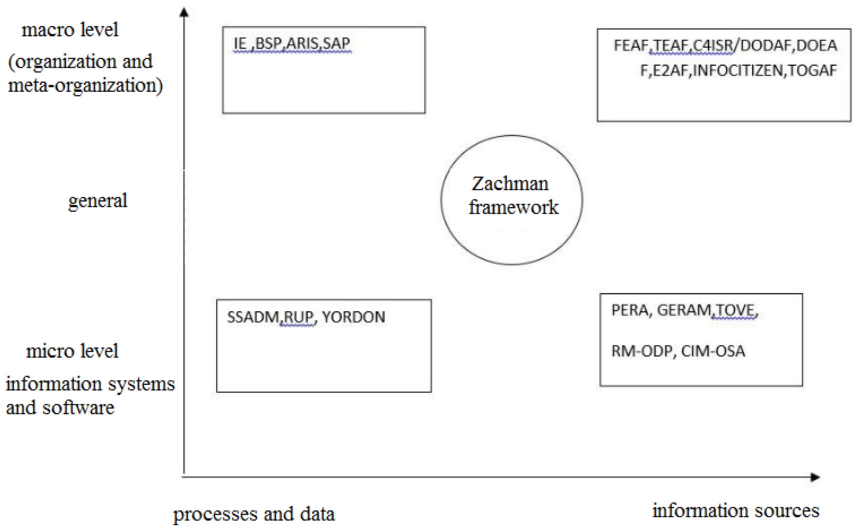


Figure 1: Zachman Framework

Positive points of the Zachman framework:

- It is simple to learn and work with it.
- It is comprehensive, and covers all aspects and perspectives.
- It is based on a set of basic descriptions called architecture models.

Weaknesses of the Zachman framework:

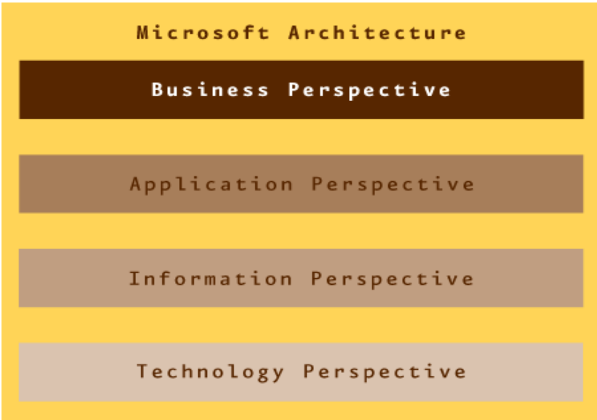
- It does not discuss security, Zachman only wrote a note on this case, and did not explain it.
- It does not discuss transitional standards, rules and strategies. Motivation column can be somehow combined with the sequencing plans and strategic view.
- Some columns such as timing cycles and motivation are not as useful as other columns.
- This framework has no specific methodology and tools.
- It does not define how IT and business are aligned.
- No attention is paid to the relationship between aspects, something that received attention by architecture methods after introducing mapping matrices between components of the columns.
- Framework and models have no rules (Andrew Macaulay, 2004).

So we can say, in the Zachman framework, the planner, the subcontractor, the designer and the builder pay attention to the scope of the system in relation to the environment, the role of system in the organization, the software needed to achieve business objectives and the infrastructures needed to construct the system, respectively (Sowa, J., Zachman, J, 1992).

1.3. Microsoft enterprise architecture

Microsoft EA framework is a two-dimensional framework that focuses on four basic perspectives (business, applications, information and technology) and four different levels of details (conceptual, logical, physical, and contextual).

Table 1: Andrew Macaulay, 2004



1.4. Research questions

To what extent is there an alignment between applications architecture and business architecture in Mobile Telecommunication Company of Iran (MCI Company)?

To what extent is there an alignment between information architecture and business architecture in MCI Company?
To what extent is there an alignment between information architecture and applications architecture in MCI Company?

2. Literature review

2.1. Business-IT alignment

Today, alignment is one of the main challenges of organizations, because they cannot compete without it. The effect of investment in IT on organizational performance is clear for researchers and executives. In fact, business-IT alignment, over the past 20 years, is considered one of the 5 priorities for management systems (Palvia, & Whitworth, 2002; Pick, & Ward, 2000; Gottschalk, 2001).

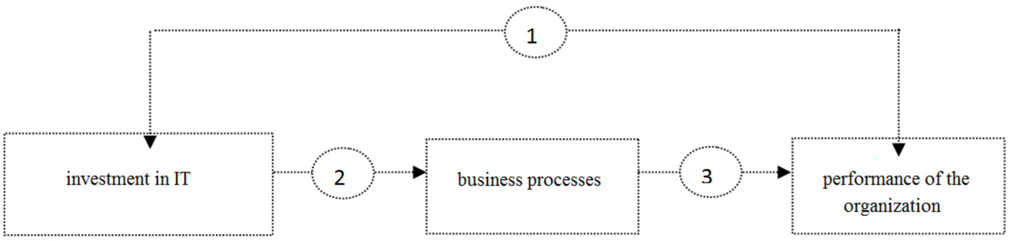


Figure 2: IT and performance of the organization
Dehning & Richardson, (2002)

Alignment is a key issue for business executives, and is among the most important issues that the IT executives face (Pop, 2001, Tallon & crimer, 2003; Trinor, 2003).
This issue is proved by multiple surveys done in the industry that reveal the executives' impressions of alignment (Hed, 2000; Kenedy, 2000; Lee, 2000; Weill, 2001).
Alignment has a significant effect on IT efficiency, and directs it to more profit in the business (Chan, 2001).
Some researchers believe that the alignment is not an issue in itself, IT is strongly combined with the business, and should not be considered separate from the business strategy, so alignment is meaningless (Smaczny, 2001).
Strategic alignment assumes that the management process is quite systematic, and everything is in full control, and the information infrastructure can be easily aligned with the management's views (Galliers R, 2003).

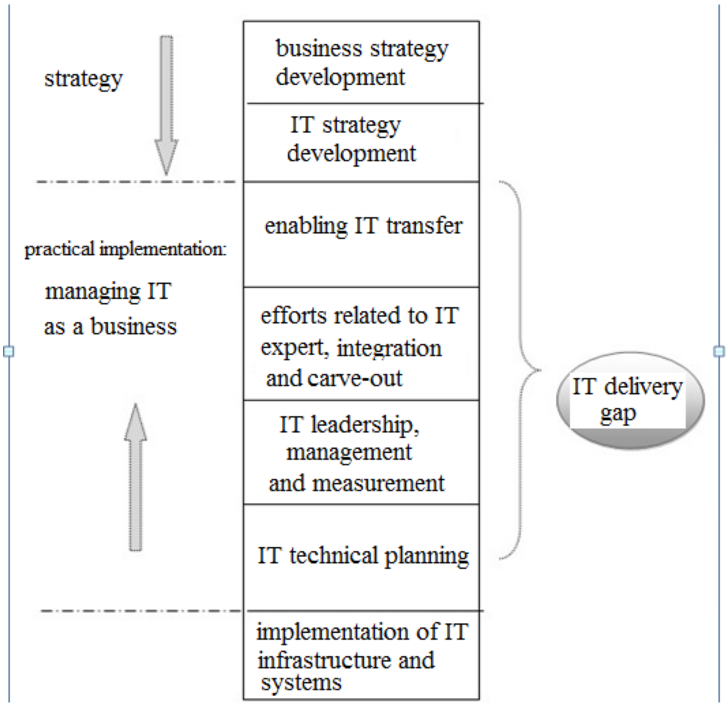


Figure 3:

3. Alignment models

3.1. - Clark Model

Clark introduced a model in 1994 that was formed based on Scott Morton's ideas in 1991. In this model, five basic factors are mentioned that affect the organization's strategic goals and alignment. The five factors include: structure, management processes, people and roles, technology and strategy.

This model shows that technology-strategy relationship is not simple or direct, and it can be influenced by the organizational culture. Relationships may be influenced by technological factors and internal and external socio-economic environments. Due to the high dynamics of an organization's internal and external environments, alignment needs to be continuously evaluated and monitored. "Management processes" is the central factor in the model. These processes come between IT and business strategy (Clark, Steve. 2001).

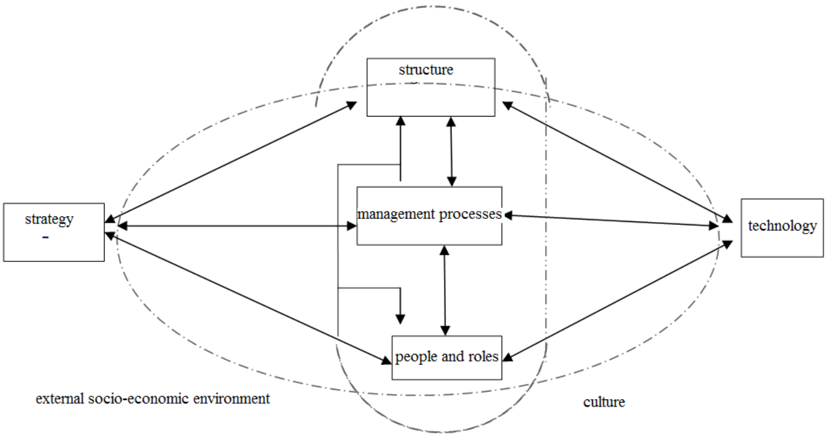


Figure 4: Clarke model

3.2. Strategic business-IT alignment model of Henderson and Venkatraman

The strategic alignment model was introduced by Henderson and Venkatraman in 1993. The purpose of the IT-oriented framework was to build a way for aligning and coordinating IT and business objectives in order to create IT added value (Henderson & J. C & H. Venkatraman, 1999).
This framework observes the business-IT alignment from two dimensions:
A) Coordination and alignment between strategic and operational areas
B) Operational integration between business and IT areas
In each of the model domains, the following cases should be identified and considered in the alignment process:
- Business strategy
- IT strategy
- Organizational infrastructure and processes

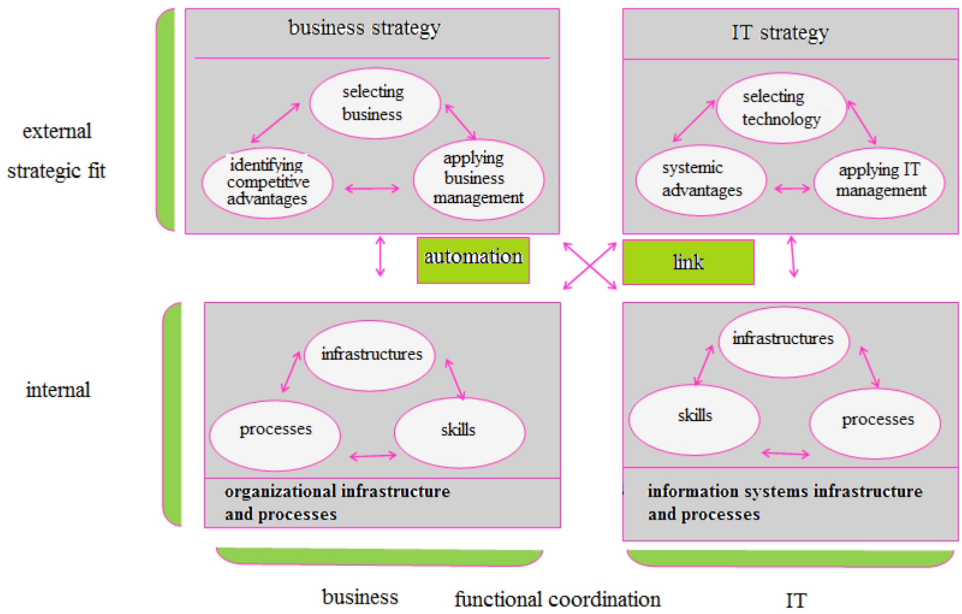


Figure 5: Henderson and Venkatraman model

3.3. Literature and the conceptual framework

“Today, most organizations suffer from lack of formal architecture. Their IT collection is like twisted spaghetti, so that new technologies are linked with their old systems (Gartner Group, 2003). Many organizations take the management as the key to successful EA: lack of a clear vision on software packages, network parts, data components and business processes also contribute to the problem. Thus, without having a clear picture of the environment, the result will be nothing, but an ineffective planning, a weak monitoring and a waste of IT resources (Camponovo, 2004).
Information systems-business alignment accounts for about 52% of information systems executives' concerns, and information systems alignment is introduced as the second most important factor in the success of organizations (CIISM, 2001).

Effective business-IT alignment requires analyzing the business problems and changes at all levels. Business- IT interface must be based on transparent and consistent business requirements and information; in fact, business related solutions should interact with IT solutions (Consurtium, 2001).

Enterprise architecture metamodel for IT-business alignment situations (Franke, Ulrik, Jan Saat, Robert Lagerstron, 2010)

This issue discusses the application of EA models in support of IT-business alignment. All approaches to alignment ignore the organizations' different situations. In fact, this paper proposes a situation-based approach to the alignment. This study distinguishes four IT-business alignment situations, each defined based on certain qualities. The qualities determining situations include:

Table 2: Qualities determining situations

IT systems	performance
	stability
	maintainability
business	flexibility
	integration and coordination
	decision support
	control & follow up
	organizational culture
IT organization	plan & organize
	acquire & implement
	deliver & support
	monitor & evaluate

3.4. Qualities determining situations

A metamodel for strategic business and IT assessment (Plazaola, Leonel et al., 2006)

A metamodel for strategic business-IT assessment was introduced by Luftman as a reference model. The approach of this article is derived from a research's results for adding applications to the organizations' real environment. According to experts' approaches, awareness and maturity levels are available in Luftman model, and are only reused for achieving more practical models. In fact, the six-dimension model of Luftman's business-IT alignment assessment is designed as a software model.

In this study, the relationship between metamodel and EA principles is shown as a guide to identify the relationships.

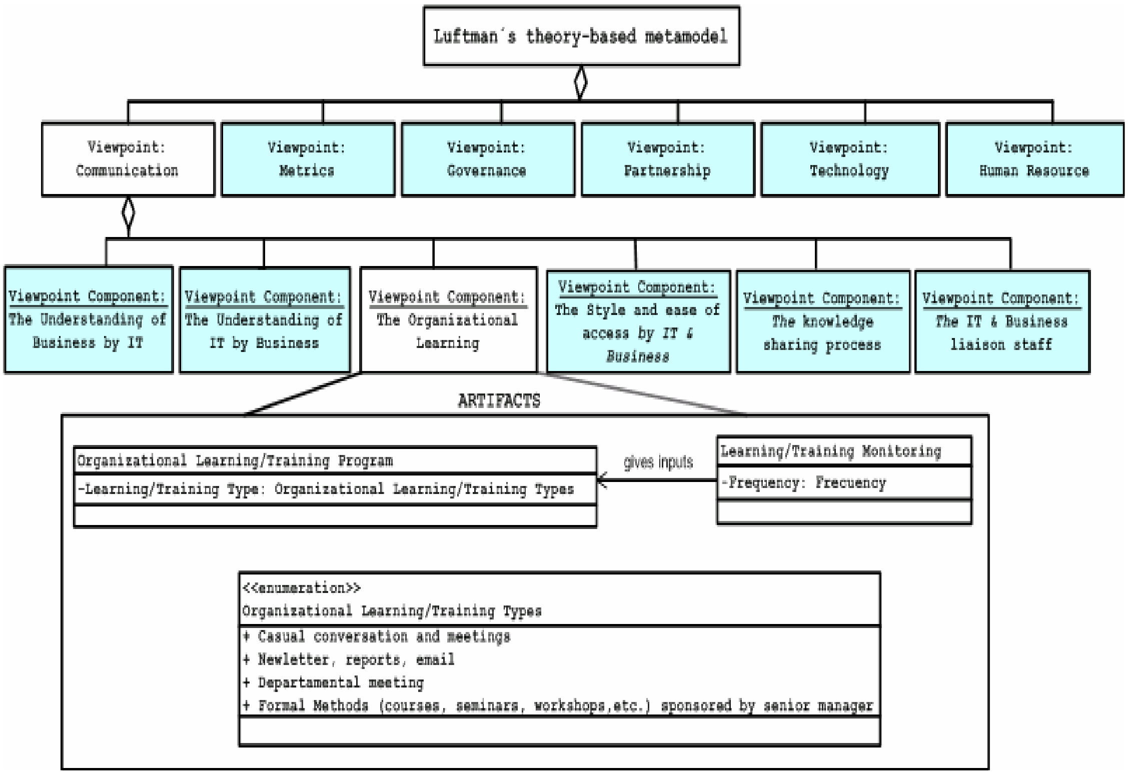


Figure 6: A metamodel designed by Leonel Plazaola

Business-IT alignment for enterprise architecture with a model designed by Alain Wegmann et al. (2007)

In this article, a solution is provided for business-IT alignment problem in the form of SEAM model for EA approach. The approach was shown with the help of a consulting firm's processes. It seems at times difficult to achieve integration, but it helps the staff understand the project development.

The nature of the model facilitates meeting different needs, and leads to a better understanding of aspects such as concepts and principles, conceptual modeling of business processes, the simulation of behavior and data.

In SEAM designed for EA, people, IT and software applications are embedded. Each system is analyzed separately. In this model, designers can implement IT-related projects.

Results: This model is a powerful training tool for educating engineers. In fact, it is presented as a factor enabling the business strategic planning, organizational internal processes and intermediate processes with information systems.

An integrated enterprise architecture framework for business-IT alignment (Novica Zarvic, 2005)

To integrate processes and IT, an integrated EA framework is needed. The EA framework is a conceptual framework for describing the business-IT architecture and their alignment.

In this paper, an integrated framework is presented combining well-known frameworks such as Zachman, four-domain, TOGAF and RM_ODP.

Results: The results provide an integrated EA framework which can be used in various organizations, and enable organizations to understand each others' architecture frameworks.

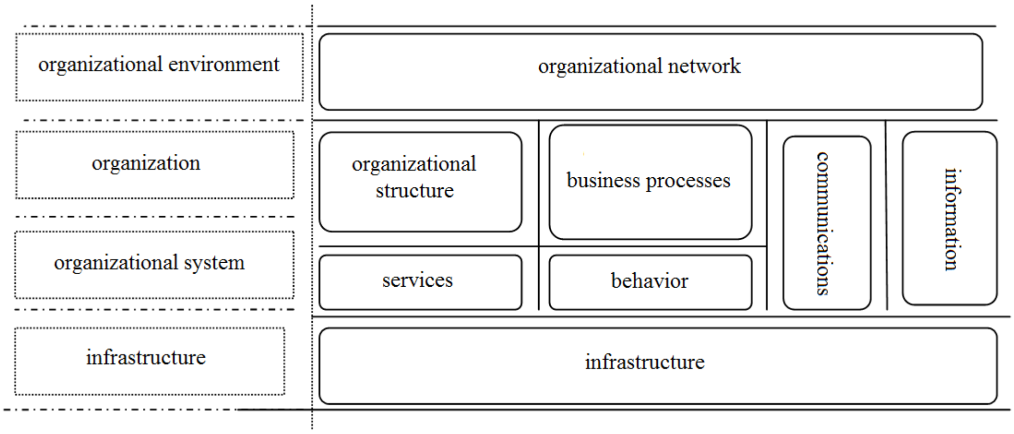


Figure 7: Integrated enterprise architecture framework

3.5. Theoretical principles

Applications architecture and business architecture are aligned in MCI Company.
Information architecture and business architecture are aligned in MCI Company.
Information architecture and applications architecture are aligned in MCI Company.

- "The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution." (Standard IEEE, 147)
- A base information source which explains the structure of mission and information required by the organization, and technologies needed to support them, and defines the transition process to implement these technologies (O'Rourke et.al. 2003).
- The overall structure of IT planning system that directs the optimal use of IT towards achieving business strategies (Perk & Beveridge, 2003).

3.6. The advantages of enterprise architecture approach

EA has numerous advantages which can be grouped into two general categories:

A) General advantages of enterprise architecture approach for business

1) Compliance with strategy
2) Reduced redundant activities and sector-wide approach
3) The nature of the EA process
4) Making targeted investments

B) Advantages of enterprise architecture approach for IT organizational unit

1) Reduced redundancies
2) Effective systems
3) Increased systems' quality
4) Systems' integration
5) Increased understanding of other organizational units
6) Producing reusable documents and products (Akhavan Niaki, 2001)

3.7. Types of enterprise architecture

There is no single definition for the EA. One of the reasons is that there are various impressions for this concept. Three major groups deal with the issue of EA; therefore, there should be three different definitions for it. Each definition includes its own objectives, reasons, views and beneficiaries.
A) process- oriented EA
B) government-oriented EA
C) IT-oriented EA
In this case, EA aims to align IT and business to improve the efficiency and productivity. This approach focuses on the lower levels, and aims at the integrated information systems and effective IT infrastructure, so the systematic organization of IT improves the efficiency, and reduces the costs. (www.agildata.org)
This approach is usually shown by a multi-layer structure of sub-architectures related to the profession, information, systems, data and technology. Each layer transfers its needs to the lower layer and, on the other hand, it is responsible for meeting the needs of higher layers (Mohtarami, Amir, 2003).

3.8. Validation and analysis of data

The sample group is a subset of the statistical population by which the researcher is able to generalize the results to the entire population (Sekaran, 2009: 295). Sample units of this study include senior executives, executives and employees of the IT department in MCI Company who are somehow related to the implementation of EA and IT activities in the organization.

3.9. Data collection tools and methods

The main methods are:
1. **Library research**: It is used in all scientific studies. Some studies use this method in a part of the research process, while others are totally dependent on library researches (Hafeznia, 2008: 164). To collect data on theoretical principles and literature, library resources, articles, and required books and the Internet were used in this study.
2. **Field research**: the researcher has to go out to communicate with people, organizations and institutions to collect data. He must take his assessment tools out and collect the data using questioning, interviews, observation and video capture, and then return to his work for extracting, classifying and analyzing data (Hafeznia, 2008: 179).
For a paired comparison test among the 56 criteria for architecture approaches, 10 experts responded to the questionnaire in the form of paired comparison. For a 5-scale Likert questionnaire, 212 questionnaires were distributed among employees of MCI Company in Tehran, out of which 203 were collected, and 200 questionnaires could be analyzed.

Table 3: General structure of the questionnaires

target item	description	studied component	measures N.
item 1	The purpose is to save time and energy of manpower that will be only spent on optimal activities.	business architecture- applications architecture alignment	1-22
item 2	If aligned, the manpower receives his required transparent and accurate information on time.	information architecture- business architecture alignment	23-44
item 3	If aligned, the manpower only codifies performances and logics.	information architecture- applications architecture alignment	45-56

Table 4: Scoring the questionnaires

general form	very low	low	moderate	high	very high
scoring	1	2	3	4	5

3.10. Validity and reliability of research tools

3.10.1. Validity

It means whether the measurement tool can measure its designed features or not? Validity has different types. Since we needed the content validity which was more related to the research, it is explained here.

3.10.2. Content validity

The content validity is the expert's subjective judgment about the suitability of the measurement tool. In other words, the expert himself comments that the tool for collecting data measures the same thing as the researcher intends to measure. This is a common method used in this study. Content validity of a test is usually determined by experts in the studied subject, so the content validity depends on the experts' judgment. In this research, items have been reviewed by the supervisor and advisor professors to ensure their content validity, and it was decided to use them with some changes (proportional to the studied organization). At the end, the validity was approved by applying the desired changes. The validity of the questionnaire was then approved in the form of face validity.

3.10.3. Reliability

Reliability is one of the characteristics of measurement tool, and deals with the issue that to what extent the measurement tool produces the same results under the same condition.

There are different methods to calculate the reliability. The Cronbach's alpha coefficient was used in this study to calculate the reliability of questionnaires used for multi-scale items.

This method is used for calculating the internal consistency of measurement tools such as questionnaires or tests that measure different features. In these tools, there can be different values as the answer for each item. To calculate the Cronbach's alpha coefficient, first the variance of scores for each subset of items and the total variance should be calculated. Then the following formula is used to calculate the value of alpha coefficient.

$$ra = \frac{j}{j-1}\left(1 - \frac{\sum S_i^2}{s^2}\right)$$

In this equation:
j = number of items

S_i^2 = variance for each item

s^2 = variance for all items

The zero value of this coefficient represents non-reliability, and +1 represents a full reliability (Sarmad et al., 2009: 169).

Table 5: The Cronbach's alpha for the research questionnaire

Cronbach's alpha	
0.765	research questionnaire

The Cronbach's alpha mean obtained for the questionnaire is higher than 0.7 which represents the desired reliability of the questionnaire. It should be noted that the Cronbach's alpha coefficient ranges between 0 and 1. The closer this coefficient is to 1, the more reliable the questionnaire items are.

3.11. Data analysis methods

This study used descriptive and inferential statistics to analyze the data from the questionnaire.
1. **Descriptive statistics**: frequency and frequency percentage were used to describe the sample.
2. **Inferential statistics**: in this study and according to the progress of research project, Kolmogorov-Smirnov test, the one-sample t-test and the Expert Choice software were used to assess the normality of variables, to evaluate the research questions, and to achieve other results and enrich the findings, respectively. SPSS and Expert Choice were the software programs used in this study.

3.12. Statistical analysis

3.12.1. Descriptive statistics

Profile

Gender: 61% of the sample were men and 39% were women.

Table 6: Distribution of respondents by gender

gender	frequency	percentage
men	122	61
women	78	39
total	200	100

Academic qualification: about 52% of employees have a bachelor's degree, and 6% have a PhD. This indicates this statistical population is well educated.

Table 7: Distribution of respondents by academic qualification

academic qualification	frequency	percentage
high school diploma	33	16.5
associate degree	25	12.5
Bachelor's degree	105	52.5
Master's degree	36	18
PhD	1	0.5
total	200	100

Years of service: The following table shows that most of subjects had 10- 20 years of service.

Table 8: Distribution of respondents by years of service

years of service	frequency	percentage
less than 5 years	15	7.5
5-10 years	71	35.5
10-20 years	92	46
more than 20 years	22	11
total	200	100

Organizational position: As seen in the following table, most of subjects were experts.

Table 9: Distribution of respondents by organizational position

organizational position	frequency	percentage
employee	33	16.5
expert	113	56.5
supervisor	44	22
executive	10	5
total	200	100

3.13. Inferential statistics

3.13.1. Kolmogorov-Smirnov test for the normality of research variables:

Factor analysis pretest for the distribution of target variables was necessary. So, first this condition was examined for the research variables.

Table 10: Kolmogorov-Smirnov test for the normality of research variables

	number	**mean**	**standard deviation**	**Z Kolmogorov-Smirnov**	**(level of significance)**
applications architecture	160	65.44	11.52	1.61	0.111
business architecture	200	62.68	19.42	3.5	0.354
information architecture	200	31.7	9.62	1.582	0.627

Given that the level of significance in Kolmogorov-Smirnov test was higher than 0.05 in the above table for all three variables - applications architecture, business architecture and information architecture -, then there was no significant difference between the distribution of all variables and the normal distribution. Thus, we concluded that the distribution of research variables was normal.

3.14. Reviewing research questions

The one-sample t-test was used for reviewing research questions. Before analyzing them, this test would be explained here:

3.15. One-sample t-test

This is a method in which the mean is compared with a constant. The result of this test shows whether there is a significant difference between them or not.
Since the questionnaire was prepared based on the Likert scale (five scales), and given that in the five scale, number "3" represents the average for each item, it is possible to calculate the average score for each variable. This means that the number of items for each of these dimensions was multiplied by 3 to obtain the average score for that dimension. For example, if a dimension has 5 items, the number was 15 times the average score in that dimension. Therefore, achieving scores higher than fifteen in that dimension meant earning a score higher than the average, and achieving scores lower than fifteen meant earning a score lower than the average. Therefore, it was possible to compare the mean of each dimension with the average score in the related dimension. If there was no significant difference between the mean scores and the average score, it could be said that the respondents gave an average importance to that dimension. If there was a significant difference between the mean scores and the average score, and it was numerically higher than the average, it could be said that the respondents gave an importance higher than the average to that dimension. If there was a significant difference between the mean scores and the average score, and it was numerically lower than the average, it could be said that respondents gave an importance lower than the average to that dimension.

Research question 1: To what extent is there an alignment between applications architecture and business architecture in MCI Company?
To answer the above question, the one sample t-test was used whose results are as follows:

Table 11: One-sample t-test (first question)

variable	sample size	the average level (number of items multiplied by 3)	mean	standard deviation	T value	degrees of freedom	*p*-value
first research question	200	66	67.51	13.2	1.53	178	0.047

According to the above table, respondents' mean score in variables of applications architecture and business architecture is significantly higher than the average score of this component (66). This finding means that the variables of applications architecture and business architecture are aligned.

Research question 2: To what extent is there an alignment between information architecture and business architecture in MCI Company?
To answer the above question, the one sample t-test was used whose results are as follows:

Table 12: One sample t-test (second question)

variable	sample size	the average level (number of items multiplied by 3)	mean	standard deviation	T value	degrees of freedom	*p*-value
second research question	200	66	68.75	20.11	1.93	199	0.016

According to the above table, respondents' mean score in variables of information architecture and business architecture is significantly higher than the average score of this component (66). This finding means that the variables of information architecture and business architecture are aligned.

Research question 3: To what extent is there an alignment between information architecture and applications architecture in MCI Company?
To answer the above question, the one sample t-test was used whose results are as follows:

Table 13: One sample t-test (third question)

variable	sample size	the average level (number of items multiplied by 3)	mean	standard deviation	T value	degrees of freedom	*p*-value
third research question	200	36	38.21	16.62	1.88	199	0.031

According to the above table, respondents' mean score in variables of information architecture and applications architecture is significantly higher than the average score of this component (36). This finding means that the variables of information architecture and applications architecture are aligned.

In what follows, indicators of each research question are ranked using Expert Choice performed by the paired comparison. First, we explain this software:

3.16. Analyzing Expert Choice

Data analysis for examining the accuracy of research questions or hypotheses is of particular importance. Today, in most of the researches that rely on data collection, data analysis is considered the main and most important part of the research.

Therefore, after introducing the research method, it was necessary to use the statistical data and methods to test hypotheses. Using statistical techniques and MADM operational research including AHP which were consistent with the methodology and type of variables, data were collected and analyzed, and research hypotheses were statistically tested. Excel2007 and Expert Choice were used for quickly performing this research.

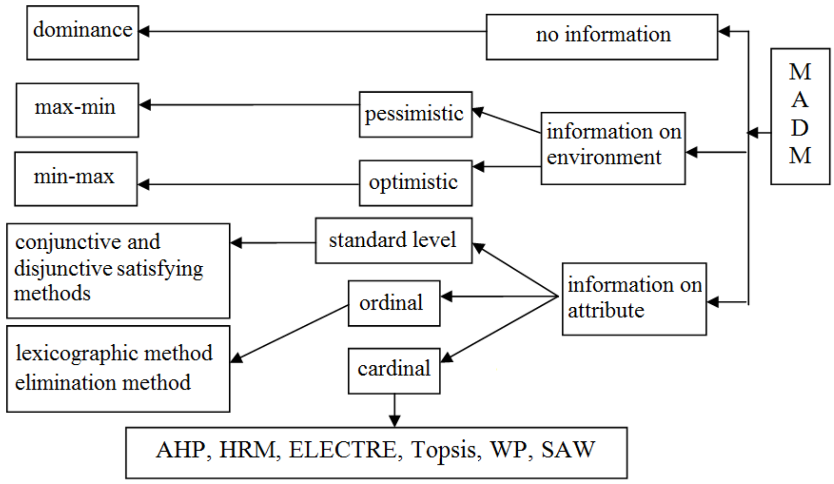


Figure 8: Various MADM methods in terms of application

3.17. Analytic hierarchy process (AHP) method

AHP is one of the most comprehensive systems designed for multiple criteria decision making (MCDM). This technique allows the hierarchical formulation of the problem, and also let the decision maker consider various qualitative and quantitative criteria. This process also involves various options in decision making, and makes the criteria sensitivity analysis possible. This method is based on paired comparisons, and facilitates the judgment and calculation. Another advantage of this calculation method is the decision compatibility and incompatibility (Ghodsipoor, 2007, 15).

Thomas L. Saaty, founder of AHP, mentioned the following four principles as the principle of hierarchy process, and provided all calculations, rules and regulations based on these principles. These principles include:

1. **Reciprocal condition**: if the preference of component A to component B is equal to n, the preference of B to A will be equal to 1/n.

2. **Homogeneity**: component A must be homogeneous and comparable with component B. In other words, the superiority of A over B cannot be infinite or zero.

3. **Dependency**: each hierarchical component can be dependent on its higher level component(s), and this dependency can linearly continue to the highest level.
4. **Expectations**: Whenever a change occurs in the hierarchical structure, the assessment process should be done again (Ghodsipoor, 2007, 18). AHP processes can be seen as follows:

3.18. How to make a multi-attribute decision

After the executives and decision-makers felt the need for multi-attribute decisions, these methods should be used practically. To this end, the following steps are necessary:
• forming a decision matrix
• quantifying the decision matrix
• descaling the decision matrix
• giving weight to the desired attributes
• selecting the appropriate techniques for solving problem
• solving the model and selecting the best answer

Calculating attributes weights based on the decision maker's paired comparisons and judgments
To use these methods, first, attributes paired comparisons matrix is formed like the following equation.

$$D = \begin{bmatrix} a_{11} & . & . & a_{1n} \\ . & . & . & . \\ . & . & . & . \\ a_{n1} & . & . & a_{nm} \end{bmatrix} = \begin{bmatrix} \frac{W_1}{W_1} & . & . & \frac{W_1}{W_n} \\ . & . & . & . \\ . & . & . & . \\ \frac{W_n}{W_1} & . & . & \frac{W_n}{W_n} \end{bmatrix}$$

In this matrix, $a_{ij} \to \forall i, j = 1,2, \ldots, n$ represents the decision maker's personal judgment about the paired comparison between i attribute and j attribute. In other words, i attribute to j attribute is of different importance and preference for a decision maker. For example, it can have the same importance or high preference and numerous other states. For using them, first these preferences were quantified using the table (1-4), and then were used.

Table 14: Saaty's scale for quantifying qualitative criteria

explanation	**definition**	**intensity of importance**
i has an equal importance to j	equal importance	$a_{ij}=1$
i is rather favored over j	low importance	$a_{ij}=3$
i is highly favored over j	high importance	$a_{ij}=5$
i is very highly favored over j	very much important	$a_{ij}=7$
i is much favored over j	absolutely more important	$a_{ij}=9$
	intermediate value	$a_{ij}=2,4,6,8$

On the other hand, $\frac{w_i}{w_j}$ represents the actual weight of i attribute to j attribute whose values are unknown and should be determined. It is clear that:

$$\forall i = j \rightarrow a_{ij} = 1$$

This equation suggests that one attribute is of equal importance to itself. On the other hand:

$$a_{ji} = \frac{1}{a_{ij}}$$

This means that if for the decision maker, i attribute value to j attribute equals a_{ji}, then j attribute value to i reverse attribute is $\frac{1}{a_{ij}}$.

For descaling the paired comparisons matrix, each component of the decision matrix was divided by the sum of components of the corresponding column in this method. The equation is as follows.

$n_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}$ and (j=1, 2, ….,n)

In this equation, n_{ij} represents the normal value of i attribute to j attribute.

3.19. Examining the compatibility of judgments

One of the advantages of AHP is to examine the compatibility of judgments to determine the criteria and sub-criteria importance coefficients. In other words, how much is compatibility of judgments observed in forming the binary comparison matrix of criteria (matrix A)? When the criteria importance is estimated relative to each other, the inconsistency in judgments will be possible. This means if A_i is more important than A_j, and A_j is more important than A_k, then A_i should be more important than A_k. Despite all efforts, people's preferences and feelings are often inconsistent and few. So there should be a measure to reveal the inconsistencies in judgments.

The mechanism Saaty used to examine the incompatibility in judgments is to calculate the incompatibility rate (IR) derived from the incompatibility index (II) divided by the random index (RI). If this coefficient is less than or equal to 0.1, the compatibility in judgments will be accepted, or judgments should be revised. In other words, the binary comparison matrix of criteria should be re-formed:

$$I.I. = \frac{\lambda_{\max} - n}{n-1}$$

Given the number of criteria (n), RI can be derived from the following table (Momeni, 2006, p. 44):

Table 15: RI according to the number of criteria

N	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Finally, the IR of matrices can be obtained from the following formula.

$$I.R. = \frac{I.I}{R.I}$$

Table 16: Criteria/ factors affecting applications architecture, business architecture and information architecture

evaluation criteria		sub-criteria		sub-criteria
business architecture- applications architecture alignment	1	lowest number of applications	12	activity of business process
	2	need for integration	13	upgradable systems
	3	simplifying application	14	highly available systems
	4	reduced application reforms	15	online support
	5	single application	16	easy adjustment system
	6	multiple transactions	17	entry of the same data
	7	upgradable applications	18	providing password
	8	highly available applications	19	operations coverage
	9	supporting activities	20	improper applications
	10	critical hardware maintenance	21	flexible technology architecture
	11	smaller temporary teams	22	agile IT architecture
information architecture- business architecture alignment	23	one unit of information	34	control usability
	24	updated information	35	classification
	25	eliminating information unit	36	naming
	26	operational process activity	37	usability evaluation
	27	an understandable identifier for employees	38	analyzing cost and benefit of information
	28	viewable to audience	39	maintaining the continuity of use
	29	standard tools	40	sufficient information to do the job
	30	standard applications	41	detailed information
	31	known sources	42	transparent information
	32	controlling the integrity of information units	43	updated information
	33	controlling units' transparency	44	work-related information
information architecture- applications architecture alignment	45	identifying applications	51	transporting content into a data warehouse
	46	creating applications	52	replica versions
	47	reusing applications	53	ensuring the dependency
	48	identifier	54	collecting data from the system
	49	designing tools	55	encoding information
	50	data warehouse	56	not changing the data structure

Table 17: Prioritizing the criteria for applications architecture and business architecture

N	components	weight	priority	N	components	weight	priority
1	lowest number of applications	0.138	1	12	activity of business process	0.042	8
2	need for integration	0.1	3	13	upgradable systems	0.031	12
3	simplifying application	0.105	2	14	highly available systems	0.03	14
4	reduced application reforms	0.076	5	15	online support	0.026	15
5	single application	0.08	4	16	easy adjustment system	0.024	16
6	multiple transactions	0.047	7	17	entry of the same data	0.021	17
7	upgradable applications	0.051	6	18	providing password	0.021	18
8	highly available applications	0.04	9	19	operations coverage	0.018	19
9	supporting activities	0.03	13	20	improper applications	0.018	20
10	critical hardware maintenance	0.034	11	21	flexible technology architecture	0.016	21
11	smaller temporary teams	0.037	10	22	agile IT architecture	0.014	22

Table 18: Prioritizing 56 criteria

evaluation criteria		sub-criteria	weight	rank		sub-criteria	weight	rank
business architecture-applications architecture alignment	1	lowest number of applications	0.079	1	12	activity of business process	0.024	12
	2	need for integration	0.057	3	13	upgradable systems	0.018	19
	3	simplifying application	0.06	2	14	highly available systems	0.017	19
	4	reduced application reforms	0.043	5	15	online support	0.015	23
	5	single application	0.046	4	16	easy adjustment system	0.014	26
	6	multiple transactions	0.027	10	17	entry of the same data	0.012	29
	7	upgradable applications	0.029	8	18	providing password	0.012	30
	8	highly available applications	0.023	13	19	operations coverage	0.011	32
	9	supporting activities	0.017	20	20	improper applications	0.01	35
	10	critical hardware maintenance	0.019	18	21	flexible technology architecture	0.009	36
	11	smaller temporary teams	0.021	15	22	agile IT architecture	0.008	40
	23	one unit of information	0.035	6	34	control usability	0.014	28
	24	updated information	0.031	7	35	classification	0.012	31
	25	eliminating information unit	0.028	9	36	naming	0.011	33
	26	operational process	0.027	11	37	usability evaluation	0.009	37

		activity						
information architecture- business architecture alignment	27	an understandable identifier for employees	0.023	14	38	analyzing cost and benefit of information	0.011	34
	28	viewable to audience	0.018	20	39	maintaining the continuity of use	0.009	38
	29	standard tools	0.02	16	40	sufficient information to do the job	0.007	44
	30	standard applications	0.017	21	41	detailed information	0.007	45
	31	known sources	0.019	17	42	transparent information	0.009	39
	32	controlling the integrity of information units	0.016	22	43	updated information	0.007	46
	33	controlling units' transparency	0.014	25	44	work-related information	0.007	47
information architecture- applications architecture alignment	45	identifying applications	0.013	27	51	transporting content into a data warehouse	0.006	49
	46	creating applications	0.015	24	52	replica versions	0.006	50
	47	reusing applications	0.008	41	53	ensuring the dependency	0.005	51
	48	identifier?	0.008	41	54	collecting data from the system	0.004	52
	49	designing tools	0.007	43	55	encoding information	0.002	56
	50	data warehouse	0.006	48	56	not changing the data structure	0.003	55

4. Conclusion

Since a research only helps to clarify some aspects of reality, and is incapable of describing it as a whole, and that the clarification of a problem often creates other various questions and issues that their response requires new research and surveys, the results of the study are presented based on the collected data and statistical tests, and then suggestions based on research findings and suggestions for future research are made. Research limitations are also mentioned.

This research aimed to examine applications architecture-business architecture, information architecture-business architecture, and finally the information architecture-applications architecture alignment situation. In this study, after reviewing the research theoretical principles and the related literature, three architecture approaches and 56 attributes to evaluate these approaches were identified.

It should be noted that in this study to ensure the content validity of the questionnaire, the questionnaire was given to experts, and eventually, after applying the needed changes, its validity was confirmed. After validation, questionnaires were distributed among MCI Company's employees (N=31) to examine the reliability of the questionnaire. According to standard Cronbach's alpha, the final approval to distribute and collect the questionnaire was given. Thus, 235 questionnaires were distributed, out of which 200 questionnaires could be analyzed. Finally, the results of data analysis were gathered. Also, to increase the quality of results, a questionnaire was designed for the paired comparison of criteria of each style of architecture, and was given to 10 experts to perform the paired comparison for it. One sample t-test results to study "applications architecture-business architecture", "information architecture-business architecture" and "information architecture-applications architecture" alignment showed the above architectures were aligned. The analysis results obtained from the Expert Choice also showed that among 56 studied criteria, lowest number of applications and simplifying application had the highest priority, and encoding information and not changing the data structure had the lowest priority.

The first research question that applications architecture and business architecture were aligned was approved. Therefore, by improving the components of "lowest number of applications", "need for integration", "simplifying application", "reduced application reforms", "single application", "multiple transactions", "upgradable applications", "highly available applications", "supporting activities", "critical hardware maintenance", "smaller temporary teams", "activity of business process", "upgradable systems", "highly available systems", "online support", "easy adjustment system", "entry of the same data", "providing password", "operations coverage", "improper applications", "flexible technology architecture" and "agile IT architecture", business architecture- applications architecture alignment also increased. The results of this hypothesis are consistent with researches of Amini Motlagh and Seyedi (2009), Franke, Saat and Lagerstron (2010), Oderiande (2010), Pedro Sousa and Carla Pereira (2009) and Marv (2009).

The second research question that information architecture and business architecture were aligned was approved. Therefore, by improving the components of "one unit of information", "updated information", "eliminating information unit", "operational process activity", "an understandable identifier for employees", "viewable to audience", "standard tools", "standard applications", "known sources", "controlling the integrity of information units", "controlling units' transparency", "control usability", "classification", "naming", "usability evaluation", "analyzing cost and benefit of information", "maintaining the continuity of use", "sufficient information to do the job", "detailed information", "transparent information", "updated information" and "work-related information", business architecture-information architecture alignment also increased. The results of this hypothesis are consistent with researches of Amini Motlagh and Seyedi (2009), Franke, Saat and Lagerstron (2010), Oderiande (2010), Pedro Sousa and Carla Pereira (2009) and Marv (2009).

The third research question that information architecture and applications architecture were aligned was approved. Therefore, by improving the components of "identifying applications", "creating applications", "reusing applications", "identifier?", "designing tools", "data warehouse", "transporting content into a data warehouse", "replica versions", "ensuring the dependency", "collecting data from the system", "encoding information" and "not changing the data structure", information architecture-applications architecture alignment also increased. The results of this hypothesis are consistent with researches of Amini Motlagh and Seyedi (2009), Franke, Saat and Lagerstron (2010), Oderiande (2010), Pedro Sousa and Carla Pereira (2009) and Marv (2009).

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