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Future of information retrieval systems and the role of library and information science experts in their development

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Abstract

Many organizations and businesses are using futurology to keep pace with the ever-increasing changes in the world, as the businesses and organizations need to be updated to achieve organizational and business growth and development. A review of the previous studies has shown that no systematic research has been already conducted on the future of information retrieval systems and the role of library and information science experts in the future of such systems. Therefore, a qualitative study was conducted by reviewing resources, consulting experts, doing interaction analysis, and writing scenarios. The results demonstrated 13 key factors affecting the future of information retrieval systems in the form of two driving forces of social determinism and technological determinism, and four scenarios of Canopus star, Ursa major, Ursa minor, and single star. The results also showed the dominance of technology and social demand and its very important role in the future of information retrieval systems.

Keywords

Experts, futurology, information retrieval systems, Library and Information Science (LIS), scenario writing

Introduction

Due to the Fourth Industrial Revolution, the boundaries between physics, digital technologies, and biology of global production systems were rather blurred, while the rapid evolution of technology has caused profound changes in people's social life and business affairs. It is predicted that with the advancement of IOT technologies, artificial intelligence, robotics, augmented and virtual reality, and 3D printing, the world of production and consumption will also evolve (Martin and Leurent, 2017), just as the advent of the World Wide Web and the Internet has revolutionized the search and retrieval of information (Jansen et al., 2000).

Information retrieval systems comprise a long-established field of study with new extensive research possibilities, which has long been in the focus of scholarly attention. (Meadow, 2013) has divided the emergence and evolution of modern information retrieval systems into six periods as follows: (1) pre-1950s systems: during this period, documents were created using manual indexing and categorization to search for and replace original sources; (2) post-1950s: in this decade, due to the conditions created after World War II, many changes were made in indexing and search; (3) the 1960s: during this period of more computer memory, interactive access was formed and the ARPANET project was developed by the US government;

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(4) the 1970s: the beginning of text search. In this decade, interactive information retrieval systems such as Dialog, Orbit, Medline, and Lexis appeared; (5) the 1980s: in this period, full text, internet, and search engines emerged; and (6) the 1990s, in which the World Wide Web was born.

In addition to the above divisions, another period can be named, which began with the invention of the Semantic Web. Traditional information retrieval systems no longer exist alone, and semantic and conceptual retrieval systems have come to life (Dridi, 2008).

A review of the literature showed that the future of information retrieval systems has not been studied futuristically, and researchers have seldom introduced important paths in the future of information retrieval system by examining components. Lewandowski (2005), for instance, points out that no search engine can cover all the Web contents and suggests a movement from the traditional retrieval to the Web data retrieval. Likewise, Singhal (2008) considered the increase of the web content as the most important problem of future data retrieval. Besides, a group of researchers considered the future of information retrieval systems as working on social networks (Patil et al., 2005).

Futurism is a field of study that has recently attracted the attention of numerous researchers. The word futurism was first used on BBC in 1932 by H.G. Wells, who called for far-sighted departments. The first characteristic of futurism is the creation of new and creative ideas, and if we want to define it, we must say that the term futurism and other words are synonymous with a systematic process in which one tries to say something about the possibilities of the future comprehensively and based on future possibilities, changing impulses, as well as changing factors and relationships (Kuosa, 2014).

Dator (1998) believed that future is the result of interaction among the following four elements: trends, events, images, and actions. Trends are a flow of developments that cannot be easily changed. The trend of pressure depends on the course of history, which, we believe, will continue in the future (Kuosa, 2014). Among the most important trends are the global population breakdown and a relative increase in the global median age. In general, the existence of a trend can be confirmed via statistics or collective agreements. Contrary to trends, events represent a historical breakdown, occur abruptly, and affect everything—for instance, a coronavirus epidemic. Images and actions, as their names imply, involve people's perceptions of future and the actions they take based on those perceptions.

There are many tools and methods to draw futures. The scenario writing is a common method of future studies, which has long been used by governmental planners, business executives, and military experts as a powerful tool to help make decisions in the face of uncertainty. The idea behind it is to think about possible futures so as to minimize unanticipated results and expand the way the managers view the future possibilities and potentialities (Mietzner and Reger, 2005).

In futurology, the factors that cause a forward movement are called driving forces. Two traditional driving forces in social systems are the pulling and the pushing forces. The pushing driving force refers to a wide demand for something such as the access to information in the current world, particularly the access to health information after the COVID-19 epidemic. Generally, information retrieval is a technical concept, and all human-related technologies influence and are influenced by the structure and values of the society in which they emerge (Ferkiss, 1985). In our modern society, an urgent need is felt for having access to accurate information and enhancing the information retrieval systems and process. On the other hand, technology, which has always had a great role in information retrieval systems, continues to grow and is able to change society. In such a situation where access to accurate, comprehensive and detailed information has become a vital factor in human life, how does society seek and gather information? How about the next 10 years? We know that people seek information retrieval, but we do not know exactly how it will be accomplished (Jansen et al., 2000), because information retrieval is inherently a human interactive activity between the searcher and an information environment. Given that social habits, behaviors, and attitudes of society undergo a profound change after great events, like before and after the First and Second World Wars, the behavior of contemporary society in information use, and retrieval will not be the same as before the coronavirus; therefore, the main aim of the present study is to investigate probable futures of the information retrieval systems in the presence of two driving forces of social determinism and technological determinism, and also to demonstrate the possible part of the Library and Information Science (LIS) experts in these hypothetical futures.

Materials and methods

In this work as a scenario-based futuristic study, the steps were based on Giesecke (1998) proposed model. This model has eight steps: (1) identifying and selecting the subject of decision making, (2) identifying the key factors in the environment, (3) identifying the driving forces, (4) ranking the driving forces and the main forces based on their importance and the degree of their uncertainty, (5) selecting the main areas or assumptions for scenario development, (6) completing or developing the scenarios, (7) examining the scenario outcomes, and (8) identifying the indicators that help monitor change as progress is made.

After the identification and selection of the information retrieval systems as research subject (first step), the next six steps of Giesecke's model were grouped into three sections as follows. Concerning the eighth step, due

to the fact that identifying the indicators that help monitor change is used more for organizations (King, 1998), the eighth step of Giesecke's model was not applied in this study. However, a part of the changes commensurate with the scenarios was mentioned in the discussion and conclusion section.

Identifying the key factors

In order to identify possible factors affecting the future of information retrieval systems, the method of document analysis was used. In this step, first the search database was selected and the search formula was prepared as follows:

TITLE: ("Information retrieval" OR "Information search" OR "Knowledge retrieval" OR "Knowledge search" OR "Information retrieval system*" OR "Semantic search" OR "Semantic retrieval" OR "Keyword search" OR "Keyword retrieval" OR "Semantic search engine*" OR "Keyword search engine*" OR "Information Search Tool*" OR "Search Tool*" OR "Search engine*").

Scopus database was selected for the search. After searching with the mentioned formula, in 2018, 5645 initial records were selected. After reviewing the titles of the selected records, 653 titles were selected with the consent of the research team, and their full text file was downloaded to study and extract possible effective factors.

A total of 97 factors were identified by reviewing the literature (Table 1). The identified factors were reviewed several times and the need for a classification was felt. The search began to find a scientific model for categorizing these factors. Various models such as STEEPLED,[1] STEEPLE,[2] DESTEP,[3] PESTEL,[4] SLEPT,[5] and PEST[6] (Craig and Campell, 2005) were identified. Finally, the PEST model was found to be appropriate to classify the initial factors identified. This model, as a strategic business tool, was first proposed by Aguilar (1967) to examine the business environment. It was applied by organizations to discover, evaluate, organize, and monitor big factors that can affect our environment now and in the future. Aguilar (1967) considers environmental survey as the study of information about events and communications in the external environment that is the subject under study and the knowledge that helps managers and professionals in carrying out future activities. This model has been applied in various research studies, for example, Schlecht et al. (2021).

In order to create a better order and understanding of the extracted factors, the PEST model was used. PEST monitors political-legal, economic, socio-cultural, and technological factors and variables. Accordingly, the 97 factors identified were 36 technological factors, 35 social factors, 15 legal-political factors, and 11 economic factors (Table 1).

Since it is not possible to plan and map the scenarios based on the 97 primary factors extracted, key factors must be identified and ranked based on the degree of uncertainty of the interaction matrix. For this purpose, the interaction matrix was used to identify the key factors affecting the future of information retrieval systems, and MICMAC software was used to analyze the matrix. To this end, an expert panel including 13 experts in the field of information retrieval was formed and the factors were placed in the form of interaction matrix in order to understand the effectiveness and impact of each factor.

In order to understand the position of the variables from the calculation of a complex matrix, we used MICMAC software. MICMAC software examines the identified factors in five categories: (1) influential variables, (2) relay variables that are divided into two groups: (a) risk variables and (b) target variables, (3) dependent or output variables, (4) independent or excluded variables which are divided into two groups: (a) discrete variables and (b) secondary lever variables, and (5) regulatory variables (Arcade et al., 1999; Godet et al., 2008; Van't Klooster and van Asselt, 2006).

Finally, 13 key factors affecting the future of textual information retrieval systems were identified.

Identifying, ranking, and selecting driving forces and main forces

After analyzing the interaction matrix using MICMAC software and identifying the key factors using the opinion of 13 experts who participated in the previous stage, driving forces were identified and ranked. Consequently, the two main driving forces that can be used to set the scenarios were selected. Schwarz (1991) also believes that the scenario writing process begins with the search for driving forces, the forces that affect the output of events and originate from key factors.

Selecting, developing, and examining the scenarios and mapping

After identifying the driving forces, the theme and context of the mapping of scenarios were selected according to the current and imagined situation in the form of four scenarios. We were inspired by astronomy to map scenarios. We chose the theme of astronomy because the metaphorical concept behind the title of each scenario well illustrated the position of information science professionals in the imagined future of information retrieval systems. Finally, the scenarios were mapped and written according to the expected outcomes of the key factors of each propulsion and the monitoring indicators of changes in each scenario.

In the end, in order to evaluate the scenarios, first of all, the written scenarios with an evaluation form were provided to the experts participating in the research. After

Table 1. List of identified factors affecting the future of textual information retrieval systems.

Technological factors	Sociocultural factors	Legal-political factors
1. New Content Templates	1. Increasing media literacy	1. Copyright
2. Media convergence	2. Globalization	2. Dismantling state monopoly as to produce news and information
3. Increased content production	3. Demographic trends	3. Presence of private sector in information production and its marketing
4. Intelligent mode of information acquisition	4. Collaborative environments	4. Moving retrieval systems from research to business arena
5. Broadband expansion	5. Social networks	5. Increasing the importance of information in international relations
6. New Web Generation	6. Personalized learning environments	6. Increasing scientific production
7. Big data	7. Learning analysis	7. The state's Focus on Knowledge-Based Businesses
8. Cloud Computing	8. Increased demand for university education	8. The state requirements in increasing bandwidth and reduce Internet connectivity costs
9. Augmented Reality	9. Increasing the need for information	9. Compete to gain further share in the future of information retrieval systems
10. Converting printed materials to electronic	10. Converting Web into the main source of information	10. Supply and demand equilibrium in relation to information
11. Using artificial intelligence and natural language processing	11. Differences in the expression of information needs	11. Increased state investment in the information market
12. Cross-Language Information Retrieval	12. The problem of choosing terms to express concepts	12. development of international relations
13. Incorrect matching in existing retrieval systems	13. Increase Web Search	13. Launching international companies supporting information retrieval systems
14. Faster and cheaper hardware	14. Increase the available information volume	14. Cooperation between science production systems
15. Convert traditional library into digital	15. Epidemic use of social networks	15. Boosting the State information system
16. Automation of data retrieval process	16. The dependence of jobs on information	Economic factors
17. Development and evolution of search engines	17. Appraising the role of information in personal, social, economic and professional correlations	1. Reduce the cost of Internet connection
18. Increasing free resources (open access)	18. Attitude of managers to the status of information science	2. Reduce hardware-related costs
19. Emergence of collected or combined resources	19. The stance of the field of information science in people's view	3. Increasing the importance of retrieving accurate information in business
20. Difficult to work with retrieval systems (current)	20. Growing Information and Knowledge jobs	4. Mobile applications
21. Retrieve online information	21. Expanding competing disciplines of information science in the field of data retrieval	5. Low knowledge of brokers about retrieval systems
22. Possibility to identify catchwords	22. Philosophy of Information Science	6. Commercial Considerations of Brokers
23. Increasing Internet resources	23. Emphasis on Entrepreneurship	7. Measuring the efficiency and effectiveness of information retrieval systems
24. How to organize and index information	24. Specialization	8. Moving from industrial economy to the information economy
25. Formulating the request	25. Emphasis on commercialization in the field of science	9. The corporate monopoly like Elsevier in providing scientific information
26. Improve computer user interface	26. Decreasing job-centric libraries	10. Developing electronic businesses
27. Improving the technology infrastructure	27. Synchronization of information science through education groups with technological changes	11. dismantling the monopoly of big commercial corporations

(Continued)

Table 1. (Continued)

Technological factors	Sociocultural factors	Legal-political factors
28. Semantic retrieval	28. Reduction of information gap among different social groups	
29. Reduce the age of computer users	28. Reduction of digital gap among different social groups	
30. Increase Internet penetration rate	30. increased curiosity and willing for knowledge among different social groups	
31. development of platforms under mobile	31. Different demands of users in the future	
32. using the capabilities of web 2.0 for developing the retrieval systems	32. Making information science theories applicable	
33. developing marketing and business platforms	33. Practical teaching of information organization methods	
34. Conceptual and structured retrieval	34. Teaching new methods of information retrieval	
35. Objects image retrieval	35. updating university curricula	
36. Use of ontology in information retrieval		

Table 2. Initial analysis of the matrix and its statistical data. .

Degree of filling	Sum	Potential effect	Strong effect	Moderate effect	Weak effect	Without effect	Number of iterations	Matrix dimensions
39.23903	3692	109	894	1275	1414	5717	2	97

Table 3. Direct effects of indicators on each other.

Index	Influence	Index	Dependence
Technology	4074	Technology	2468
Legal-political	682	Legal-political	676
Sociocultural	1276	Sociocultural	2787
Economic	617	Economic	715

receiving the opinions of experts and their actions, the final scenarios were developed and completed.

Results

Preliminary analysis of the interaction matrix showed that according to the dimensions of the matrix, there were a total of 9409 options for the matrix, of which 5717 were zero relations, which means that the factors did not affect each other or were not affected by each other. 1414 relationships had a number of low impact-influence, 1275 relationships had a medium-impact type, 894 relationships had a strong influence-effect type, and finally 109 relationships had a potential type. The degree of saturation of the matrix was 39.23903%, which indicated that more than 39% of the selected factors had an effect on each other. Out of a total of 9409 numbers in the matrix, there were 3692 evaluable relationships in the matrix (Table 2).

In a cross matrix, the sum of the rows of each factor indicates the degree of influence and the sum of the columns indicates the degree of dependence of that factor in terms of other factors. According to the analytical results of the matrix, technological, and political-legal variables were more influential and less dependent, showing that these indicators have a greater impact on the system. On the other hand, sociocultural and economic variables were more dependent and less influencing. Among the mentioned variables, the technology index components were much more influencing than dependent, while sociocultural index components were much more dependent than influencing (Table 3).

According to Figures 1 and 2, the position of each variable in the influence/dependence chart is identified.

The distribution of the driving forces indicates the stability or instability of a system. According to Figure 3, the system is unstable, but its instability is not very high due to

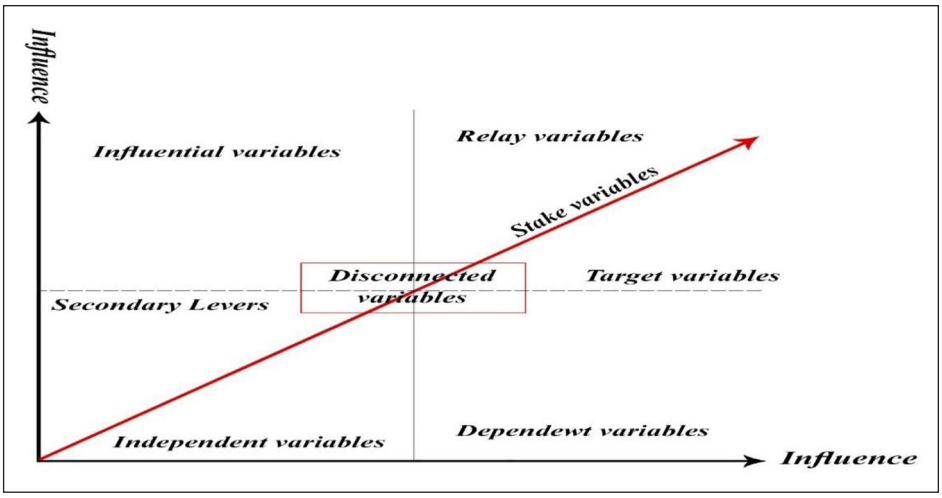

Figure 1. Influence and dependence variables (Godet et al., 2008).

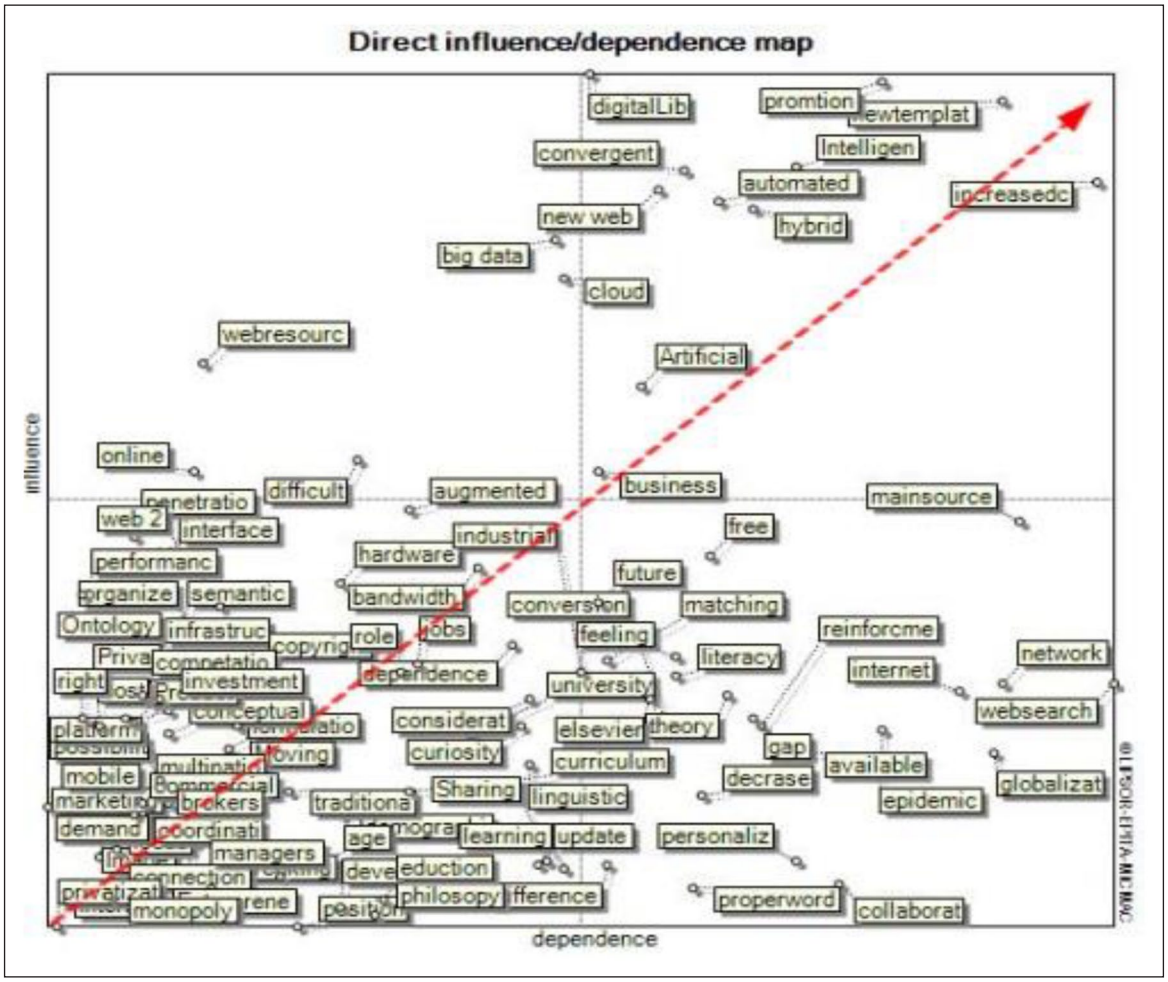

Figure 2. Direct effects of driving forces.

the shape of the scattering of driving forces in the influence-dependence plane. As the diagram shows, the scatter of the driving forces is highest in the area of independent variables with low influence-dependence, while the second most scatter of the driving forces is in the section of dependent variables that have a high dependence. The rest

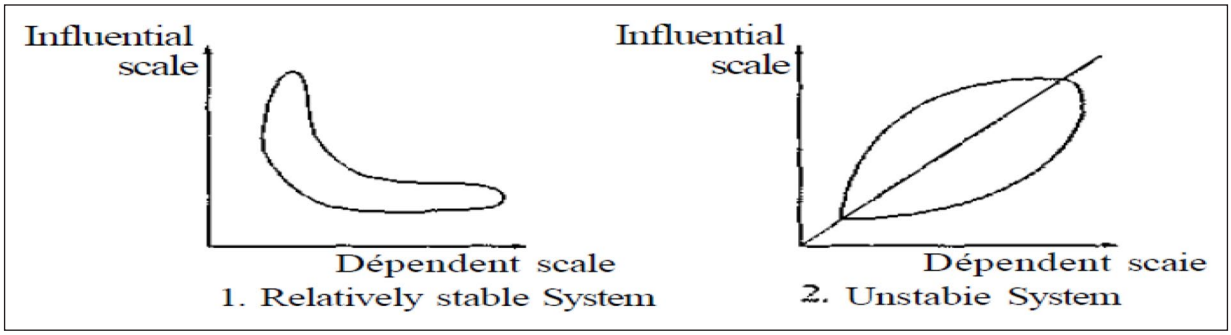

Figure 3. Stable and unstable systems (Godet, 1994).

of the driving forces are in the part of the relay variables that are highly influencing and dependent, while the least number of driving forces are in the section of the effective variables.

Influential variables

According to the chart, the influential variables are located in the northwestern part of the chart. These variables are the most important components in any system. Since the system is unstable, a low number of variables are included in this section, and therefore the big data, the increase of internet resources, and the online information retrieval are the closest variables to this section. In other words, these forces can highly affect the system.

Relay variables

These variables are located in the northeastern part of the chart and have a high influence-dependence property and their nature is mixed with instability. These variables are divided into two categories: risk variables and target variables. Risk variables are around the northeast diagonal line and have a high capacity to become a key player. Some of the driving forces that fall into this category are: new content formats, the new generation of the web, media convergence, the conversion of traditional libraries to digital ones, the use of artificial intelligence in information retrieval, and the smartening of methods of data collection, emergence of hybrid resources, and cloud computing, etc.

The target variables are located below the area of the northeast diagonal line and close to the *X*-axis, which in the present study, no driving force was observed in this section.

Dependent or output variables

These variables are located in the southeastern part of the chart and have a high influence and a low dependence. As the diagram shows, after the part related to the independent variables, most of the variables are scattered in this area. Increasing web search, having collaborative environments, monopolizing business companies such as Elsevier in providing information, reducing hardware-related costs, reducing internet connection costs, updating academic curricula, applying information science theories, reducing the digital gap between groups in society, and increasing the amount of information available are among the variables in this section. Besides, the difficulty of choosing the right word to express a concept, personalized learning environments, and globalization are the variables included in this section.

Excluded or independent variables

Independent variables are located in the southwestern part of the chart and are neither very influencing nor very dependent; in other words, they do not stop a variable or help in its evolution. The highest number of variables in the present study are in this section which are divided into two categories: discrete and secondary lever. The influence of secondary leverage variables is greater than their dependence and they are located above the diagonal line of the southwestern part. Variables such as semantic information retrieval, use of ontologies in information retrieval, use of Web 2 capabilities to develop information retrieval systems, use of improved computers' user interfaces, information organization and indexing, and use of improved technology infrastructure, etc. are located in this section.

The second group includes discrete variables that are located near the coordinate axis and below the southwest diagonal line. Reducing the age of using information retrieval systems, reducing traditional libraries, increasing curiosity and the desire to know in society, promoting practical training on information organizing methods, including business considerations of brokers, demographic trends, and updating LIS departments, etc. are the variables in this section.

Regulators

These variables are located near the center of gravity of the chart and are indeed regulative and act as a secondary

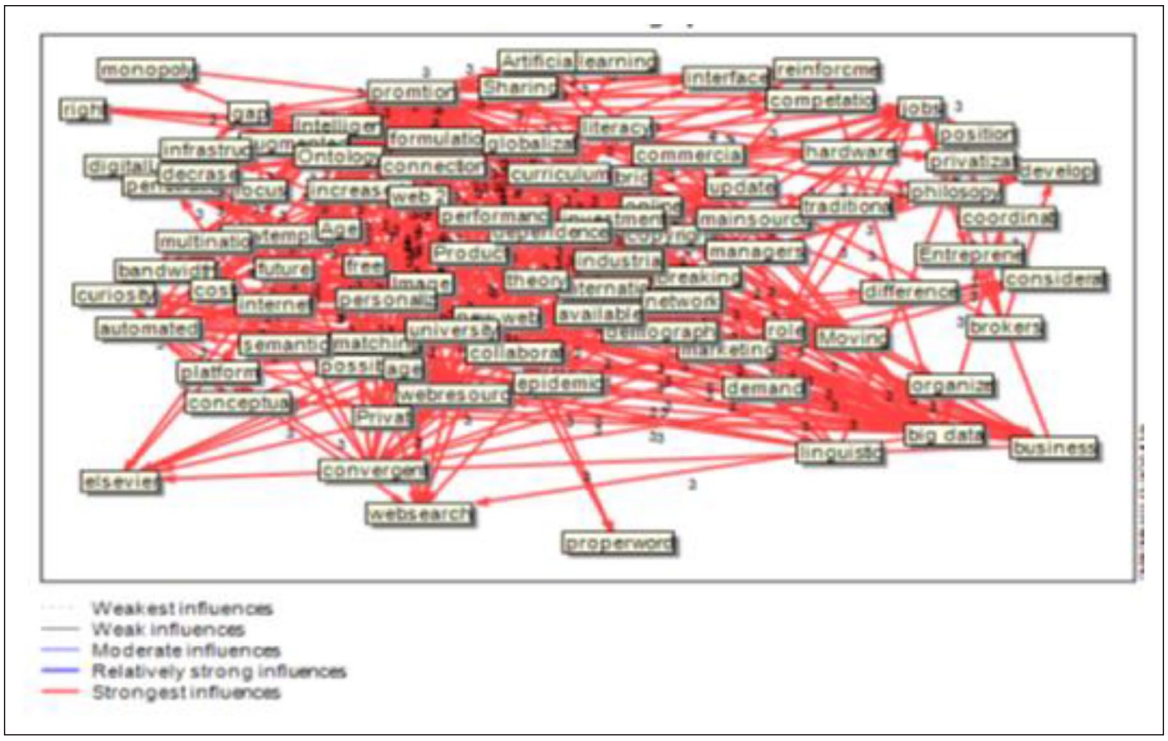

Figure 4. Direct relations between key influencing factors.

lever. They can also be upgraded to influencing variables or risk and target variables. Considering different demands of users in the future, increasing free resources, developing business practices, adding augmented reality, moving from industrial economy to information economy, including faster and cheaper hardware, increasing bandwidth, media convergence, removing misalignment in systems, retrieving current information, and increasing the sense of need for information are among the regulatory variables.

Finally, Figure 4 shows a graphical representation of the indicators under study and their relationships.

Selection of key factors influencing the future of textual information retrieval systems

In order to select the key factors influencing the future of textual information retrieval systems, the direct and indirect effects of forces were investigated. In structural analysis, variables were sorted by effect or effectiveness. According to Gordon (2009), the objective is to estimate the probability of an event or the size of trend based on the occurrence (or not) of the other events and the size of the other trends. To this end, both direct and indirect effects were measured. Godet (1994: 91) also pointed out that direct relationships alone are not enough to reveal the variables that have a great impact on the problem and indirect relationships should also be considered.

From the key influencing factor of rank 13 onward, a gap has occurred in the direct influencing rank of the key factors. For this reason, this point was selected as the cut-off point for selecting key influential factors. Examination of 13 key factors (Table 4) selected on the basis of direct and indirect influence showed that these forces were exactly repeated in both factors and only in some cases their rank was changed.

The 13 key factors selected are: (1) converting traditional libraries to digital, (2) developing and upgrading search engines, (3) developing new content formats, (4) making data collection methods smarter, (5) increasing media convergence, (6) increasing content production, (7) developing new generation web, (8) automating information retrieval processes, (9) developing hybrid resources, (10) including big data, (11) including cloud computing, (12) increasing internet resources, and (13) using artificial intelligence and natural language processing in information retrieval.

Selecting the driving forces and mapping the scenarios

In scenario-based planning, after identifying the initial factors and key factors, in order to map the scenarios, the driving forces that affect the future of textual information retrieval should be extracted from the identified key factors. In this stage, sometimes a key factor can be a driving force and sometimes several key factors together form a driving force.

Based on the steps mentioned and obtaining the opinion of experts who participated in the previous stage, the two

Table 4. Driving forces and their key factors.

Driving force	Key factors
Technological determinism	Developing and upgrading search engines, increasing content production, developing new content formats, making data collection methods smarter, including cloud computing, developing new web generation, including big data, using artificial intelligence and natural language processing, and increasing media convergence
Social determinism	Developing hybrid resources, increasing internet resources, transforming traditional libraries into digital ones, automating information retrieval processes

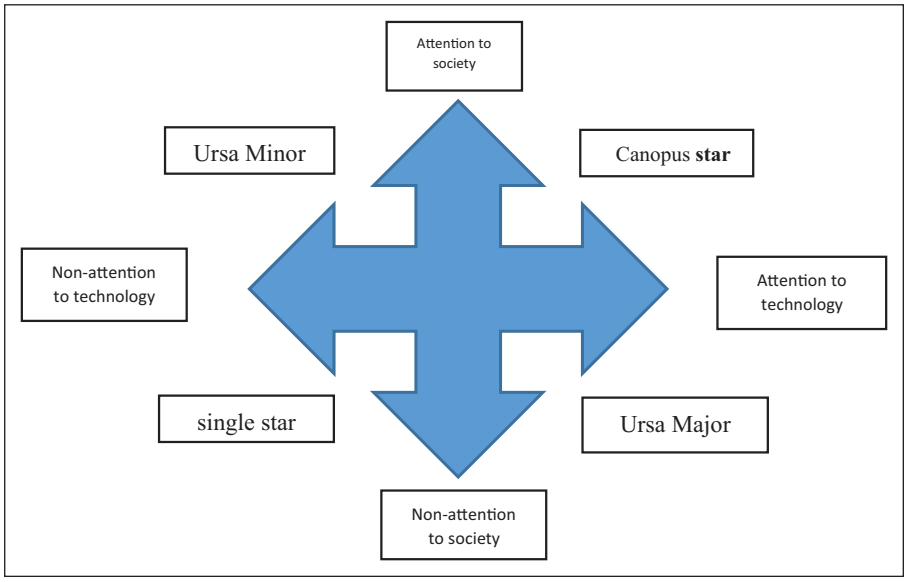

Figure 5. Structure of the scenario matrix and how each scenario is formed.

driving forces of technological determinism and social determinism were selected as the main driving forces of the future of textual information retrieval to map scenarios, respectively (Table 4).

From the perspective of technological determinism, technology is an independent force capable of causing social changes. According to Dafoe (2015), this kind of view of technology has existed since the 1980s and has two characteristics: (1) technology is based on an internal logic and independent of social impacts, and (2) technological evolutions determines social changes in a certain method; and perhaps Marshal McLuhan can be called one of the most famous technology determinists. Opposite to this view is the view of social determinism, in which the relationship between society and technology or media is examined, in such a way that social and political factors take precedence over technological factors. In fact, social determinists put more emphasis on such things as conditions of production, mode of use, values, goals, skills, control, and access (Rangel and Keller, 2011).

However, in the present study, technological determinism and social determinism do not mean that these two phenomena are independent of each other. According to the research team, dependent variable information retrieval is influenced by technological advances and social demand, so the future scenarios of textual information retrieval systems can be based on two driving forces of technological determinism and social determinism. Figure 5 shows the matrix structure of the four scenarios and how each scenario is formed.

Accordingly, four scenarios: "Canopus star," "Ursa major," "Ursa minor," and "single star" were written for the future of textual data retrieval systems. Canopus is a symbol of unattainability, so in this scenario, LIS professionals have an unattainable role in the future technological environment along with the high social demand that exists from them.

In Ursa Major, LIS experts play an essential role in using technology, accompanying the fifth generation industrial revolution, but they have failed to use it to create a need in the users, and therefore have not afforded to introduce themselves as the cause of these changes and/or respond to the general public demands. The Ursa Minor of the LIS experts tells the story of a prince of an extinct dynasty, having royal blood and yet devoid of wealth and high social status. Finally, in single star scenario, LIS

professionals are like a single star in the sky: although they have light, their light is neither warming nor illuminating.

Canopus star

First, it is required to visualize the environment in which this scenario (as well as other scenarios) takes place. Technology is one of the few phenomena that, whether we are with it or not, continues to grow and develop. In this scenario, the two phenomena of biological ecosystem and information ecosystem of society are very different from the present time.

The biological ecosystem of society is heavily involved with new technologies to facilitate work processes, increase productivity, and obtain news and education—with a variety of media in which paper no longer plays an important role. On the other hand, the life of society is dependent on obtaining accurate information. Previously, information was considered as a commodity for gaining power and wealth, but now the retrieval of accurate news and information is tied to the first human need, which is to preserve survival.

On the other hand, the information ecosystem of the society has also changed which has led to extensive changes in information carriers, communication channels, methods of news and information provision, methods of production and distribution of information and cultural goods, unprecedented increase in volume of information and storming of information. The first sparks of these changes occurred with the Third Industrial Revolution, the advent of the Web. The Web has created a new economic and social environment influenced by information highways, wireless systems, smart machines, and proliferation of media and internet tools. On the other hand, the Fifth Industrial Revolution took place with the aim of connecting new technologies with social and industrial goals where machines and humans dance with each other (metaphorically, of course).

In such a situation where changes in the biological ecosystem and information ecosystem have caused changes in roles, characteristics, characters, and capabilities, the information scientists have not only not lagged behind these changes, but have accompanied and influenced these changes. Looking at LIS specialists is no longer the same as looking at people sitting behind a library book lending desk, because libraries are no longer the only place to provide services to these professionals. LIS professionals have been able to reach the heart of the community by managing change and establishing the right relationship with the clients (the client and not a visiting person, because many services are for a fee) going through libraries. Exactly with the ideal of the Fifth Industrial Revolution, they are trying to make the world a better place. In other words, by mastering the two fields of technology and education and improving their management skills, they have been just to point and able to cover all interests and tastes.

In this scenario, LIS experts have an unattainable role, such as Canopus Star, due to having four roles of ideation, design, production and compilation, and management and policy-making in information retrieval. In Iranian culture, Canopus is a symbol of unattainability; in this scenario, LIS experts are the same Canopus in the future of information retrieval. In this scenario, LIS experts have complete mastery over the use of new technologies, design and completion of these technologies, and the factors affecting information retrieval.

With the advent of the fifth-generation distance learning universities based on new technologies and internet features of this type of education, the need for digital resources and libraries of this kind increases. In this scene, the role of LIS experts is highlighted. LIS specialists do all the work related to converting traditional libraries to digital, including design, management, creation, organization, etc., because of their mastery of technology issues and of the factors affecting the retrieval of digital resources, as well as their mastery of the library. It is the LIS specialists who know the types of digital formats, how to produce these formats, the management of these types of libraries, and the design and organization of digital resources, and have knowledge about the methods of remote electronic evaluation.

In this scenario, information scientists, using artificial intelligence and natural language processing and according to the knowledge and experience of search engines, have designed engines that make the most of artificial intelligence and natural language processing. The search framework in these engines is based on intelligent logical learning models as well as an intelligent semantic framework for processing and quantum calculations to discover and extract search patterns, semantic relationships between keywords and the relationship between ongoing searches and past searches.

Searching in these engines designed and produced by LIS experts overcomes the weaknesses of engines produced by other experts through natural language and in an evolved form of semantic processing. In these search engines, using the capabilities of artificial intelligence and the cognition that information scientists have from the existing retrieval tools, LIS professionals have moved toward designing and launching new retrieval algorithms capable of processing and generating large data from work processes and analyzing user profiles automatically. Besides, in proportion to these processes, resources are offered to the users, and these processes and resources can be stored in personalized cloud environments, as taught to users by LIS professionals.

On the other hand, due to many problems, such as outbreaks of diseases like coronavirus, that threaten the biological ecosystem, an urgent need is felt for having access to accurate, appropriate, and comprehensive information and hence it is required to have more standard information retrieval tools and strategies in order to tackle these

hazards in the new information ecosystem where anyone can generate content and post it on the web or social networks. In this scene, what has increased the expectations and use of LIS experts in the field of textual information retrieval is the training, management, and proper policy-making of the LIS professionals.

In Canopus star scenario, LIS experts, using the four roles of ideation, design, production and development, and management and policy-making that they have defined for themselves, make the greatest effort to increase the production of combined resources, formulate general production policies, retrieve and provide information, produce good educational content for gaining skills in information retrieval, and provide new standards and indices with respect to the new biological and information ecosystem in order to evaluate the electronic content retrieved in the web and in social networks and other media. In this way, these specialists not only manage information pollution but also reduce the stress caused by information confusion.

In this scenario, due to this policy, the LIS professionals do not play a complementary role, but play a leading role in the use of new technologies and the promotion of these technologies in the field of textual information retrieval. Taking this role, the LIS specialists, considering the rich scientific experience they have since the creation of the line and the first written sources, offer new methods for collecting and clustering information intelligently. The designing of new intermediaries and interfaces as offered by these experts can increase the interactions between users and media in order to achieve accurate information.

Ursa major

In this scenario, the prevailing biological ecosystem and information ecosystem is the same as in the Canopus star scenario, and LIS experts have complete control over new technologies, ideation, design, production and development; however, due to the lack of proper management and policy-making in the case of non-profit users, the society's expectations and use of services and products of the LIS professionals in the field of information retrieval are low. In this scenario, most IT professionals focus on meeting the needs of new employers who are of financial benefits to them.

In the Ursa major scenario, LIS professionals have a good position due to their mastery of information retrieval technology issues, but due to ignoring the majority of the community, they are more concerned with benefiting from their skills because their place of service is no longer in the libraries, and in fact they are not in any way associated with the ideals of the Fifth Industrial Revolution. Accordingly, due to their lack of success in increasing the users' expectations and exploitations, they have not reached a mammoth position and state, yet.

In this scenario, the user is the missing link in the recovery chain, because all the processes of ideation, design, production and compilation are focused solely on technology, and LIS professionals have failed to link technology findings in the recovery field with their users. For example, they still focus on complex mathematical algorithms that are not understandable to ordinary people in society but work well on the web. In another example, LIS professionals use artificial intelligence and new and automated retrieval methods to generate large citation data as a metadata and make it available on the web, but it means nothing to an untrained user. It is certain that if the user is not trained, neither expectations nor uses will be created. The main weakness of LIS professionals in this scenario is the lack of management of activities and inappropriate policy in the field of technology and ignoring user training. In fact, while the LIS expert in the Canopus star scenario seeks to be all things to all people, in the Ursa major scenario only the commercial employers are satisfied with the LIS specialists.

In this scenario, LIS professionals focus more on evaluating and ranking new content formats and creating useful indicators in measuring and evaluating the content produced so that commercial brokers can use these indicators to gain material benefits, rather than on teaching users how to use these templates and how to distinguish between appropriate and inappropriate information. In other words, they know the tools and facilities of the new generation of the web, but have failed to teach automated methods of information retrieval and how to use the combined resources. These experts focus their attention in the field of big data management on data analytics and interpretation to define indicators for evaluating and validating internet resources and are organizing the web environment and generating new plans. However, they have not taught the users how to use these analyses or data in the form of the content production and combined educational resources.

In fact, what in this scenario has caused LIS professionals not to be as great as a mammoth is the lack of technology and the lack of attention to user education and ignoring racial, social, economic, cultural differences, and the breadth of tastes and interests. They do not pay attention to differences in knowledge and literacy. Not everyone is able to design a search strategy for themselves. In fact, despite all the advances in the field of information retrieval technology, LIS professionals go back to a time when searches were not performed by the end user but by librarians in libraries. They work on their islands, regardless of who travels to the island. Although they have been able to come up with good ideas for fixing the shortcomings of the existing search engines, they have largely ignored the user, and the user are unaware of it.

Ursa minor

The world of technology continues on its way whether we join it or not, because technology has affected all aspects

of the contemporary life. In this scenario, LIS specialists are like the grandchildren of a royal family who, while no longer having the former status and wealth, still have influence and role in society due to their history and the preservation of some relationships. Information scientists in the field of technologies affecting information retrieval have not been very successful and have not accompanied the phenomena in biological ecosystem and information ecosystem of society (e.g. new generation of universities or the fifth industrial revolution) and have had a very low effect on these influencing factors. They are neither designers nor innovators, nor have they been very successful in management and education. Their only strength is the relatively appropriate policy-making on some of the factors that users are interested in, which has caused users to still have high expectations and use of the services provided by them.

Besides, the users' high expectation and use of the LIS professionals' services to retrieve information is more due to the changes in the information ecosystem of society than to the success of the said professionals. Society is affected by the media, the web, social networks, web tools, health issues, etc., and hence it needs access to accurate information to meet its information demands. In this scenario, LIS specialists continue to provide services in libraries, and because the library is known as an information source throughout history, people in the community have trust in library and LIS experts and refer to the library.

The disadvantage for LIS professionals in this scenario is that they have not been able to provide their services in a way that can be provided outside of libraries. Employers are not looking for them to identify, extract, and develop information retrieval strategies, and only use tools produced by other professionals. One of the strengths of LIS professionals in this scenario is their ability to use new innovations in information retrieval within libraries, although they still need to be trained by other IT retrieval professionals so that they can use these tools. In this scenario, LIS specialists are not only unable to produce new tools and methods of retrieval, but also do not even have the ability to improve these tools and methods.

Here, LIS professionals do not have the role of leading, guiding, and influencing, but they have maintained their educational role well and have mostly focused on this role. Not only have they been involved in the production of hybrid resources and their use in libraries, but they have also done well in educating users in the use and recognition of these resources and have managed to change the increase of the internet resources in the web environment into an opportunity for themselves. In addition to producing Internet resources, which mainly have educational content, these specialists have a good help in standardizing platforms, indexing and validating Internet resources, and organizing this group of resources due to the nature and foundations on which this field is built.

LIS professionals may not play a significant role in smartening retrieval methods, using artificial intelligence, or designing and launching search engines, but they do have some technological knowledge to show a good performance in terms of producing and running digital and virtual libraries as expected by the users. This role can mostly be attributed to the dependence of these specialists on a physical or virtual place called library. That is, although the audience expects and uses the library a lot, LIS experts have not yet come to believe that by mastering technological knowledge, they can extend their sphere of influence in the field of information retrieval beyond the library framework. That is why, although they have no role in the development of automated data retrieval algorithms and processes, they have been able to teach well-designed automated recovery methods to end users and present themselves as a reliable source of training.

Single star

In this scenario, LIS experts are like a star that over time has been the only target of a meteorite attack and no longer has the illuminating light or effective heat. Their only strength is the golden past of the information scientists in ancient times, when new technologies had not affected this field.

In this scenario, they not only do not have a leading role, but also do not have a good consumer role, because if they were able to use the products of other experts in the field of data retrieval, they could at least retain their users. Not only are LIS professionals unfamiliar with their dynamic and changing environment, but they are also unable to understand their audience's needs for information retrieval and continue to focus on bibliographies and printed indexes—indexes such as citation index that has lost its validity by the changes in the criteria and standards of measurement and evaluation of science and has been confined to the dustbin of history.

In the new information ecosystem, the amount of citations to the work no longer determines the effectiveness of the work, and as such, the production of a citation index is not an indicator to show the efficiency of LIS professionals. Universities, educational institutions, and governments in the new information ecosystem have come to the conclusion that citation indicators are no longer efficient enough and so they have provided new indicators and metrics that are unfortunately not the product of the LIS professionals. They have neither the ability to manage nor measure the production of growing content, and only try to keep the production and consumption cycle of information on track. They have no role in the process of creating a new generation of web and do not know how to use its tools and facilities effectively. It should be noted that in the field of converting digital libraries into traditional ones, they have only a consumer role and all related work is done by other experts. They use content formats produced

by others and do not even know the meaning of media convergence and the benefits that can be gained in the field of information retrieval.

The final point is that in this scenario, the LIS experts have even disregarded the proverb that reads, "when in Rome, do as the Romans do!" Not only did they not accompany the wave of technology, but they also seem to be indifferent in a strange and worrying way.

Discussion and conclusion

In the present study, based on scientific approaches, it was sought to provide a picture of the future of information retrieval systems and the role of LIS specialists in the future of these systems under four scenarios. The scenarios are a tool for regulating our understanding of future environmental changes that we want to decide on, and we must accept that scenarios are not prediction (Schwarz, 1991).

If LIS professionals seek to have an identity independent of libraries, they need to move with technology and social demand. As such, there is no need for a physical or virtual place called library to define LIS professionals. In Canopus star scenario, it is the LIS specialists who direct the social demand and the growth of technologies that can be used in information retrieval. Other scenarios have shown us the consequences of falling behind in technology or social demand. This backwardness is not always a self-conscious procedure but sometimes occurs due to not understanding the needs of society, having fear by insufficient knowledge, etc., which in any case must be planned for in advance.

Finally, given that one of the major limitations of this study was to obtain the consent of recovery experts, on an international scale, to participate in this study, it is suggested that similar studies be conducted to achieve a more comprehensive list of factors affecting the future of information retrieval systems in other environments. It is also suggested that other researchers study this field using other conventional methods of futurology and compare their results. Moreover, considering the highly important role of technology in the future of information retrieval systems, it is suggested that LIS experts review the chapters of this field and the extent to which they meet the needs of technology.

Some may think that everything depends on the will of society and the advancement of technology, and the results of this research are already known. Technology and the will of society are two driving forces that have the ability to drive each other. What matters is the key factors behind these driving forces and our planning (scenarios) for them. In other words, technology and the will of society may be recognized as driving forces in other research, but they have different key factors.

Therefore, what will make the difference between LIS professionals in the future of textual information retrieval will be the type of view and planning (scenario) to deal with these two driving forces and key components.

In conclusion, the future of IR is influenced by both technology and social demand. Thus, technology and social demand guide IR and determine choices and their limits. Consequently, it is important to note that LIS professionals can direct on both social demand and the growth of technologies that can be used to retrieve information. This requires attention to the indicators of change in the context of each scenario, especially the scenario of Canopus star.

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Notes

1. **S**ocial, **T**echnological, **E**conomic, **E**nvironmental, **P**olitical, **L**egal, **E**thics, **D**emographic (STEEPLED)
2. **S**ocial, **T**echnological, **E**conomic, **E**nvironmental, **P**olitical, **L**egal, **E**thics (STEEPLE)
3. **D**emographic, **E**conomic, **S**ocial, **T**echnological, **E**nvironmental, **P**olitical (DESTEP)
4. **P**olitical, **E**conomic, **S**ocial, **T**echnological, **E**nvironmental, **L**egal (PESTEL)
5. **S**ocial, **L**egal, **E**conomic, **P**olitical, **T**echnological (SLEPT)
6. **P**olitical, **E**conomic, **S**ocial & **T**echnological analysis: http://pestleanalysis.com/what-is-pest-analysis/

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