

**Unlocking the potential of big data through open innovation on strategic foresight: An empirical analysis****Ahmad Ali Salih<sup>a\*</sup>, Jehan Ali AL-Sharayah<sup>a</sup> and Azzam Abou-Moghli<sup>a</sup>**<sup>a</sup>*Department of Business, Middle East University, Amman, Jordan***CHRONICLE****ABSTRACT***Article history:*

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The aim of this study is to examine the impact of Big Data on strategic foresight in the presence of open innovation as a (mediating variable) in the companies of the therapeutic industry and the medical supplies sector in Amman the capital city of Jordan. Out of the (121) companies making up the total of such companies, the study focused on (18) industrial companies that had more than (100) employees in total, however only (11) of those have consented to take part in the study. The study population consisted of (271) employees occupying different jobs (general manager, deputy general manager, unit manager, department manager). Due to the limited size of the population, the entire number of employees were included as participants using the comprehensive survey technique, and the number of returned and validated questionnaires for analysis were (259), representing (95.5%) of the total. In order to determine the study problem, pilot structured interviews were used in a sample of the mentioned companies. The questionnaire was employed as the key tool to measure the study variables through data collection, and the descriptive and inferential statistics methods were used to analyze the collected data, through calculations of the arithmetic mean, standard deviation, t-test and half-segmentation, exploratory and confirmatory factor analysis and the structured equation model using SMART PLS3 for hypothesis testing. The study culminated in several results, the most important of which was evidence that open innovation played a partial mediating role in the relationship between big data and strategic foresight in the companies of the therapeutic industries and medical supplies sector. Accordingly, a set of recommendations were put forward, the most important of which is to increase investment in big data in the companies due to its importance in foreseeing the future. As well as applying open innovation practices and strengthening strategic foresight practices due to its important role in avoiding extensive losses and seizing new opportunities. Highlighting the need to pay attention to open innovation practices that generate ideas and help to have strategic foresight.

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**1. Introduction**

Today, business organizations, with different activities and objectives, need to forecast potential opportunities and threats, especially those that have a fundamental impact on their survival, to increase benefits or reduce costs. This is the main reason for the need of strategic foresight; as it explores the potential future effects and their consequences on decisions and actions that aim to promote more investment in the futures (Cook et al., 2014). There appears to be a knowledge gap in applying the strategic foresight process due to the need for specialized innovation tools and people trained on these tools (El Kerdini & Hooge, 2013). The study by Cook et al. (2014) showed that the gap revolves around the doubts that strategic foresight is the process of anticipating what could happen, which is a subjective notion. Hence, arises the need for further study of such doubts about the optimal use of strategic foresight using appropriate data and tools by experienced people. Conversely, the study of El Kerdini and Hooge (2013) emphasized the need for the existence of conceptual frameworks through which benefit from the activity of strategic foresight could be realized. Also, the study of Iden et al. (2017) found that there was a small amount of empirical evidence for the strategic foresight process and a lack of relationship between theoretical research, as each study

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was emphasizing strategic foresight from a different perspective and angle. The results of the studies by Vecchiato (2015) and Reschke, (2010/A, B) were in agreement, where Reschke, (2010/A) was concerned with the biopharmaceutical industry, Reschke, (2010/B) was concerned with the pharmaceutical industry. The study of Vecchiato, (2015) agreed that there was a need to apply the strategic foresight process in organizations specifically, in the pharmaceutical industry, as indicated by Reschke (2010/A) due to its high degree of environment uncertainty, and demonstrated the need for more information and knowledge to enable biopharmaceutical industries managers to apply strategic foresight to deepen their understanding of its links and role in shaping organizations' response to the environment and increase the awareness of the reality of the added value of strategic foresight. Reschke (2010/B) also confirmed that pharmaceutical industry organizations lack the strategic foresight that is needed in such a highly dynamic environment of these industries. The studies by Reimers-Hild (2018); and Fahmi et al. (2018) supported the results of the previous studies, as they highlighted the need for leadership with sufficient knowledge about strategic foresight in the era of change to visualize the future of employees in the health care sector, and how strategic foresight provides tools that help leadership focus on the future and set plans. To confirm the presence of a knowledge gap in the Jordanian environment, specifically in the therapeutic industries and medical supplies sector, the researchers conducted structured interviews with representatives of some companies in the mentioned sector, namely Jordanian Dar Company, Petra Medical Materials Warehouse, and Medical Curve Company for Medical Supplies.

Based on the perceptions drawn from the results of the interviews, It appears that the problem of the current study lies in the presence of a knowledge gap evidenced by the limited number of studies related to strategic foresight despite the urgent need for it, and the failure to invest in the relationship between strategic foresight, big data and innovation, that may waste numerous opportunities and cause substantial threats to the important sector of therapeutic industries and medical supplies.

## 2. Theoretical background and hypothesis development

It is crystal clear that the world is undergoing major and rapid changes paralleled by an unprecedented increase in the complexity of the external business environment, evidenced by mind boggling facts and figures. According to Blazon statistics (2019), over the past two years 90% of the data in the world or what equates to 2.5 quintillion bytes has been generated (7.5 million bytes every day) and 5 billion internet searches are performed daily around the world. Moreover, given the major changes and challenges that the world has been witnessing, the latest of which was the ongoing Corona Covid-19 pandemic, which imposed an urgent need to foresee the future to cope with any change that occurred, including the effects which brought the wheel of the economy to halt, prompting organizations to try to cross this crisis with minimal losses, and the need for new database management system capable of adapting to new technology-based business models, automation, digitalization and remote work during and after the passing of this pandemic. This is expected to generate a huge amount of data that could be exploited to be better prepared in anticipation of any similar future crises to be effective in facing such crises and be able to think strategically always because the environment is enormously dynamic. Therefore, any possible future emergency or crisis. This is in line with the vision and guidance of His Majesty King Abdullah II bin Al Hussein to develop the sector of therapeutic industries and medical supplies and production in quantities that help self-sufficiency in light of the ongoing pandemic (<https://www.almamlakatv.com/news>), which emphasizes the necessity and importance of strategic foresight for the sector of therapeutic industries and supplies medical. Strategic foresight deals with environmental uncertainty, increasing complexity and dynamism in the business environment. It is an important activity for discovering and exploiting opportunities that competitors have not noticed. Its most important role is to discover concepts that create a difference, create a creative destruction, or bring about a radical change (Disruptive Concepts) in the system and restructure knowledge to help in dealing with the future using a collective conceptual framework (El Kerdini & Hooge, 2013; Adegbile, Sarpong & Meissner, 2017).

The main purpose of strategic foresight is to monitor, realize and capture the factors that lead to future changes and then deal with these variables through appropriate organizational responses (Iden, Methlie & Christensen, 2017). Strategic foresight is defined as "the ability of the strategist to identify a superior course of action, especially that which is clearly different from the current situation, and to anticipate its consequences is the focal point of a polarized debate in business strategy" (Gavetti & Menon, 2016). It was found that it was difficult to assess the quality, validity and credibility of future studies without knowing the nature of this knowledge about the future and exploring it, and since the environment is uncertain, the most issues that are dealt with is exploring unexpected situations equipped with appropriate tools to explore the unknown and help disseminate and exchange knowledge. The specialized dimensions of research for the future require a systematic or holistic assessment perspective, so it is noted that strategic forward-looking is not an easy task, for discovering the unknown, i.e. predict what can happen before it occurs. (El Kerdini & Hooge, 2013). Indeed, the process of studying the future is a very difficult and complex process that requires specific tools, such as Big data for the correct foresight (Kayser & Blind, 2017), where Big data is defined as a group of data sets that are too large and complex to be managed and processed efficiently using traditional techniques and tools (Zhong, Huang, Lan, Dai, Chen & Zhang, 2015). The study of Müller, Fay & Brocke, (2018) supported the previous notion that strategic foresight needs to collect, select and analyze Big data and thus help provide quality information that contributes to achieving competitiveness and boost the organization's ability to use strategic foresight. Accordingly, the first hypothesis is put forward as follows:

**H<sub>1</sub>:** *There is a statistically significant effect of Big data on strategic foresight at the level of statistical significance ( $\alpha \leq 0.05$ ) in the therapeutic industries and medical supplies sector in Amman, the capital of Jordan.*

The process of developing strategic foresight needs creativity, because creativity depends on exploring new knowledge paths, and therefore the need for strategic foresight is embodied in the creativity process (El Kerdini & Hooge, 2013). Open innovation is defined as “systematically encouraging and exploring a wide range of internal and external sources of innovation opportunities, consciously incorporating that exploration into enduring capabilities and resources and exploiting those opportunities on a large scale through multiple channels” (Saebi & Foss, 2015). The study of Natalicchio et al. (2017) and Hossain et al. (2016) showed that the process of open innovation needs huge data sources to be achieved, as it relies on internal and external sources of knowledge that need data and an environmental survey to obtain this amount of data to be able to achieve open innovation. The study of Prahalad and Ramaswamy (2004) supported the notion that the process of innovation cannot take place in absence of big data that allows the application of open innovation, where it is possible to identify the process of co-development that can be traced in the open innovation model. Accordingly, the second hypothesis is put forward as follows:

**H<sub>2</sub>:** *There is a statistically significant effect of big data on open innovation at the level of statistical significance ( $\alpha \leq 0.05$ ) in the therapeutic industries and medical supplies sector in Amman, the capital of Jordan.*

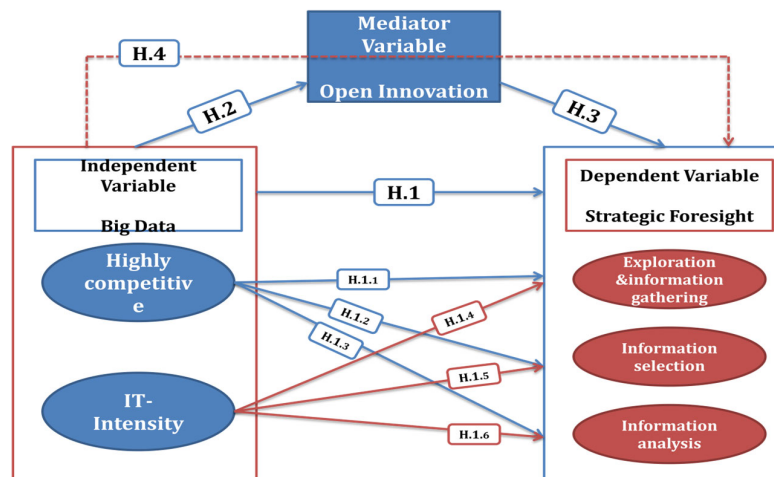
In order to achieve strategic foresight, it is necessary to use open innovation in order to achieve a better study of the future. El Kerdini & Hooge, (2013) stipulate the ways in which open innovation can function as an activity to support strategic foresight. The study by Wiener et al. (2015) found the strong relationship between open innovation and strategic foresight. While conducting the strategic foresight process, many ideas are needed, which is the role of open innovation, as it is concerned with the generation of many new ideas, thus anticipating the future and maintaining a high-quality future that is coherent and effective. Accordingly, the third hypothesis is put forward as follows:

**H<sub>3</sub>:** *There is a statistically significant effect of open innovation on strategic foresight at the level of statistical significance ( $\alpha \leq 0.05$ ) in the therapeutic industries and medical supplies sector in Amman the capital of Jordan.*

Proceeding from the foregoing and based on it, this study came to examine the impact of big data on strategic foresight through open innovation as a mediating variable in the therapeutic industries and medical supplies sector in an attempt to investigate the implications of this relationship and its role in developing the mentioned sector by testing the fourth hypothesis is put forward as follows:

**H<sub>4</sub>:** *There is a statistically significant effect of Big data on strategic foresight with the presence of open innovation as a mediating variable at the level of statistical significance ( $\alpha \leq 0.05$ ) in the therapeutic industries and medical supplies sector in Amman the capital city of Jordan.*

Fig. 1 shows the conceptual model of the study.



**Fig. 1.** The proposed study

### 3. Study Methodology

The domain of study included companies in the therapeutic industries and medical supplies sector in Amman, the capital of Jordan. Based on statistics obtained from the Amman Chamber of Industry, it was found that the number of these companies was (121) companies divided into two categories; (51) craft companies representing (42.2%) the total, and (70) industrial

companies representing (57.8%) of the total ([www.aci.org.jo](http://www.aci.org.jo)). In view of the study requirements, which necessitates the inclusion of a sufficient number of managers and employees to obtain enough observations to analyze its variables, the focus was on the industrial companies in which the number of employees was (100) or more (Al Hayat Pharmaceutical Industries, MS Pharma/Jordan, Philadelphia Pharmaceutical Manufacturing Company, Jordan Center for Biological Industries, Hikma Pharmaceuticals, International for Pharmaceutical and Chemical Industries and Medical Appliances, Jordanian Swedish for Medical Products and Sterilization, Arab Veterinary Pharmaceutical Industries (AVICO), Amman Pharmaceutical Industries, Sharq Middle for Pharmaceutical and Chemical Industries and Medical Appliances, Jordan River for Pharmaceutical Industries) that constitutes (61.1%) of (18) companies registered by Amman Chamber of Industry ([www.aci.org.jo](http://www.aci.org.jo)) for the following reasons:

- 1- The willingness of these companies to cooperate with researchers and to fill out the questionnaire.
- 2- The companies have an interest in foreseeing the future.
- 3- The companies practice big data, but this is not specific that the current study will reveal.

The Structural Equation Model was used for the purpose of testing the direct and indirect impact of the mediating variable using SMART PLS-3 software, and the confirmatory factor analysis was also used included (discriminatory validity by Fornell and Larcker technique, discriminatory validity by HTMTR technique and the cross-loading method on other factors). The use of multiple linear regression analysis included some tests and statistical indicators, such as; (the Inflation Factor VIF, Tolerance, standard and non-standard effect values, R2 index, T-test for significance of effect values, and the influence ratios for the mediating variable). This study relied on the available data to determine the mediating variable, so that open creativity was used to scrutinize the relationships and effects between the dependent and independent variables, and the relationships and effects between the mediating variable and the dependent variable.

### 3.1 Performance metrics

The items of the questionnaire were prepared and developed based on the review of the literature, and the number of questionnaire items was (62) items. Then the questionnaire was presented to (9) academic arbitrators specialized in business administration in Jordanian universities, and the questionnaire was improved in presentation and content based on the views and the arbitrators' views about the validity of the items and the extent of their suitability for the purpose for which they were developed. After applying necessary changes, the questionnaire items were reduced to (56). As for the study population, it included participants holding the following positions (general manager, deputy general manager, department manager, unit manager), and the size of the population was (271) individuals. Due to the limited size of the study population and the considering accessibility to all the participants, the entire population was included following the comprehensive survey method. Following is a presentation of the nature of the work in the study population:

**Table 3**

The nature of the work and the number of people in the study population

Nature of Work / Position	Frequency	Ratio
General Manager	7	2.6%
Deputy General Manager	14	5.2%
Division Manager	80	29.5%
Unit Manager	170	62.7%
<b>Total</b>	<b>271</b>	<b>100%</b>

## 4. Results and discussion

Table 4 presents the results of testing the study hypotheses using Smart PLS 3 software.

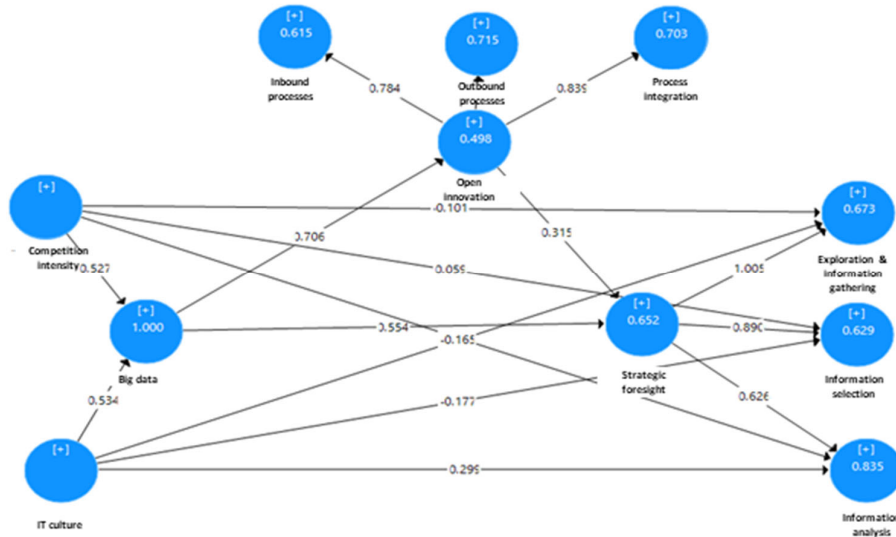
**Table 4**

The summary of testing the hypotheses of the survey

Hypothesis	impact direction	Impact factor value	t Value	Sig Indication level	R <sup>2</sup> Coefficient of determination	Adjusted R <sup>2</sup>
<b>H.1</b>	Big data → Strategic Foresight	0.554	8.652	0.000	0.652	0.649
<b>H.1.1</b>	→ Explore and gather information	0.101	2.075	0.039	0.673	0.669
<b>H.1.2</b>	Intensity of competition → information selection	0.059	2.222	0.027	0.629	0.625
<b>H.1.3</b>	→ information analysis	0.04	1.073	0.284	0.835	0.833
<b>H.1.4</b>	→ Explore and gather information	0.165	2.231	0.027	0.673	0.669
<b>H.1.5</b>	IT intensity → information selection	0.177	2.292	0.022	0.629	0.625
<b>H.1.6</b>	→ information analysis	0.299	5.709	0.000	0.835	0.833
<b>H.2</b>	Big data → Open innovation	0.706	18.154	0.000	0.498	0.496
<b>H.3</b>	Open Innovation → Strategic Foresight	0.315	4.754	0.000	0.652	0.649

**Table 5**  
The summary of the results of testing the effect of Big data on strategic foresight

Hypothesis	Paths of impact with the presence of the mediating variable	Direct impact		indirect impact		overall impact	Impact Index Ratio VAF	
		Impact value	Indication level	Impact value	Indication level		Impact ratio	Impact nature
H.4	Big data → Strategic Foresight	0.554	0.000	0.222	0.000	0.776	28.61	Partial



**Fig. 2.** Smart PLS 3 Results Diagram Structured Model for Testing the Impact of Big Data and (its Sub-Dimensions) on Strategic Foresight and (Its Sub-Dimensions)

**5. Conclusion**

The statistical results of the first main hypothesis led to its acceptance, as there was evidence of a direct and statistically significant effect of big data on strategic foresight at the level of statistical significance ( $\alpha \leq 0.05$ ) in the companies of the therapeutic industries and medical supplies sector in Amman the capital of Jordan. It was also obvious from this result that the more companies' use of databases and the more effective they were in arranging, selecting and analyzing data pertaining to the future, the more they were able to anticipate the future and the greater their predictive ability, and therefore the more they were able to seize opportunities and avoid threats in the external environment, and confront competitors and the environment in general.

Kayser & Blind (2017) study agreed with the statistical analysis of this hypothesis, as it concluded that the process of studying the future is a complex process and needs specific tools such as big data. Therefore, companies that are interested in foreseeing the future must collect, select and analyze data and convert it to information using big data.

The analysis also showed that the information technology intensity dimension has a total score value of (3.65), as it achieved a higher level of the competition intensity dimension in the big data variable, with the degrees of the dimension items ranging between (3.69-3.50). These values are classified as having a medium degree, which indicates that companies in the concerned sector use information technology as part of knowledge management, so it becomes clear that the organizations that use information technology intensively are the companies that tend to generate a huge amount of knowledge.

The statistical results of the second main hypothesis was also accepted, as it was found that there was a direct and statistically significant effect of big data on open innovation in companies in the therapeutic industries and medical supplies sector in Amman the capital of Jordan. It is the big data that generates the knowledge that creativity needs. The study by (Ghasemaghahi & Calic, 2020) agreed with these findings, as it emphasized the positive relationship between big data and the success of innovation, so that one of the most important requirements for the success of innovation is the exploitation of big new data to create, accept and implement new ideas.

The statistical results of the third main hypothesis were also accepted, as it was found that there was a direct and statistically significant effect of open innovation on the strategic foresight in the companies of the therapeutic industries and medical

supplies sector in Amman, the capital of Jordan. It is clear from the results that companies adopt the open innovation model for anticipating the future, which is a complex process by nature because it is based on the unknown, and therefore it requires a huge amount of knowledge and creative ideas, from inside and outside the company. It is therefore clear that the open innovation model enables the companies to carry out strategic foresight, which is in agreement with the findings of (Wiener, Gattringer & Strehl, 2015) in that the innovation model generates the ideas that the company needs for strategic foresight.

The analysis also showed that the total score value of the operations association dimension was (3.64), achieving the highest level between the dimensions of the mediating variable (open innovation), which ranged (3.68-3.57), classified as medium, indicating that companies in the concerned sector use open innovation and consider it part of knowledge generation, confirming that organizations that apply the open innovation model can apply strategic foresight because the essence of strategic foresight is knowledge generation.

The statistical results of the fourth main hypothesis was also accepted, as it was found that there was an indirect effect (partial effect) with statistical significance, as it was found that open innovation has a mediating role in the impact of big data on strategic foresight in companies in the medical industries and medical supplies sector in Amman, the capital of Jordan. This result shows that open innovation plays a mediating role in the relationship between big data and strategic foresight, as open innovation activates the relationship positively between big data and strategic foresight through motivating company members to bring out their creative ideas and promoting a culture of knowledge sharing between them and other sector companies in order to gain new skills and ideas that culminates in combining sources of knowledge with each other to generate innovation in the company.

The study by Martinez, (2014) agrees with this result, as it concludes that open innovation helps organizations generate new ideas through motivating individuals to create data-driven ideas, and by sharing these ideas with other sector companies, thus acquiring new skills and seeking and preparing for future factors.

### **Recommendations**

Considering the shortcomings in the therapeutic industries and medical supplies companies in Amman, the capital of Jordan, based on the results of data analysis and the testing of hypotheses, the current study puts forward the following recommendations:

- 1- Investing in big data in companies in the therapeutic industries and medical supplies sector in Amman, Jordan because of its importance in anticipating the future and applying the open innovation model through:
  - a - Improving the intensity of competition using big data
  - b- Intensifying the use of information technology in big data to enhance decisions
- 2- Enhancing strategic foresight because of its importance in avoiding major losses and seizing new opportunities through:
  - a. Boosting Investment in the exploration and gathering information about the future
  - B. Improving the selection of information about the future
  - c. Investing in future-related information analysis to increase future preparedness
- 3- Applying the open innovation model for its role in generating ideas and helping in strategic foresight through:
  - a. Motivating the members of the therapeutic industries and medical supplies companies to accept the ideas (incoming processes)
  - b. Supporting outgoing processes or the ideas of internal company personnel
  - c. Developing operations coupling because of its importance in generating creative ideas from the open innovation model and exploiting them in strategic foresight
- 4- Facilitating access to sector employees to facilitate conducting studies related to this sector to enrich Arab libraries with research related to the medical industries and medical supplies sector.
- 5- Adopting a mechanism of applying strategic foresight in sector organizations through:
  - a. Generating creative ideas from internal and external knowledge in the organization using the big data available to the organizations.
  - b. Providing awareness to the organization's personnel about strategic foresight and its importance to the organization.

- c. Encouraging personnel to explore and collect information related to strategic foresight from creative ideas that were generated from open innovation.
- d. Encouraging experienced personnel to test information relevant to future foresight.
- e. Using quality tools in order to analyze relevant information and then use it to foresee the future.

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