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Organizational improvisation and organizational agility as drivers of open innovation

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Abstract

Studies examining innovation in general and open innovation in particular indicate that innovation often requires improvisation by business management. At the same time, organizations' adoption of innovation requires a certain degree of agility that enables them to respond to changes in the innovation process. This study aims to investigate the impact of organizational improvisation on open innovation, and whether organizational agility plays a mediating role in this impact in Jordanian extractive and mining industries companies. The study relied on a descriptive quantitative approach. Data was collected using a closed-ended questionnaire based on a five-point scale, which was distributed electronically to 313 managers selected using a stratified random sampling mechanism at the top and middle levels of management. A total of 286 valid questionnaires were retrieved for statistical analysis. Data was analyzed and study hypotheses were tested using SmartPLS 4. The results of the study indicated that there is a significant impact of organizational improvisation on open innovation, and organizational improvisation has a significant impact on organizational agility, and organizational agility has a significant impact on open innovation, and that organizational agility plays a partial mediating role in the relationship between organizational improvisation and open innovation. For organizations to develop innovative products, they must rely on internal innovations, which are generated through the efforts of their employees, in addition to leveraging the innovations of others. All of this requires organizations to give their managers sufficient space to make creative decisions, take calculated risks, and rely on spontaneity and experience. All of this is supported by agile management to ensure rapid response to changes during the innovation process. The study recommended organization for enhancing the elements of organizational improvisation, including attracting talent, providing opportunities for everyone to work in teams, and empowering these teams. Organizations must foster an enabling environment that encourages employees to seek opportunities by motivating individuals to innovate and exploring diverse innovative tools and methods to cultivate a culture of open innovation. For achieving agility organization must structure the organization in a way that considers both stability and dynamism.

Keywords: Extractive and mining companies, Jordan, Open innovation, Organizational agility, Organizational improvisation.

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1. Introduction

Considering rapid technological advancements, the proliferation of knowledge, and intensifying global competition, companies have begun seeking innovative models that move beyond traditional approaches. Traditional models often struggle to keep pace with the demands of modern markets.

As a result of these challenges and in response to these new requirements, the open innovation model emerged, advocated by Chesbrough [1]. This model called for the strategic flow of knowledge across organizational boundaries (to and from the company) to accelerate development and share risks. The concept has evolved to encompass the conscious transfer of knowledge both within and outside the company. This leads to leveraging external expertise and collaborating with partners in creativity and innovation, contributing to a genuine competitive advantage in a business environment where flexibility and responsiveness have become essential [2].

Open innovation manifests in three dimensions: internal integration, which involves absorbing external ideas and technologies; external marketing, which involves marketing internal knowledge externally; and integration, which combines the first two dimensions through collaborative partnerships. It is worth noting that the application of open innovation is still complex, therefore researchers are calling for more in-depth studies on the organizational skills that help companies make this model a success [3].

Of course, there are many dynamic capabilities that foster open innovation. But in an ambiguous environment where problems are ill-defined and partners are diverse, organizational improvisation and organizational agility emerge as critical capabilities within an open innovation environment.

When existing plans are insufficient and immediate action is urgently needed, especially when standard procedures fail, the importance of strategic improvisation becomes paramount. This improvisation depends on instinct, knowledge, the resources at hand, and flexible conduct. It shows how a business can act decisively and creatively in unclear and unpredictable situations. Improvisation fosters innovation where speed and reactivity are crucial by allowing firms to try new things, adapt, and engage in value creation without being constrained by strict routines [4-6].

For improvisation to have a long-lasting effect on the company, these skills usually need to be integrated into a reliable, scalable system. The significance of organizational adaptability becomes clear in this situation. The concept of agility emerged in the early 1990s as a response to market volatility [7]. It has since evolved into a multidimensional capability that enables companies to sense and monitor environmental changes, make timely decisions, and efficiently implement change plans. Researchers often define it through three dimensions: agility of sensing, agility of decision-making, and agility of practice and application [8-10].

These two capabilities work synergistically, each reinforcing the other. Improvisation provides an immediate and creative response to unexpected events. Agility, on the other hand, provides the systems, culture, and leadership support necessary to translate those creative responses into strategic outcomes. In high-risk, resource-intensive extractive industries, companies must constantly respond to regulatory, legislative, and environmental changes. This research aims to provide a framework for building innovative, agile, and adaptable organizations.

2. Theoretical Framework

2.1. Organizational Improvisation

Organizations need quick thinking and unconventional solutions to thrive in the face of challenges. Traditional planning methods may survive, but to flourish, they need more flexible and adaptable approaches [11]. This is perhaps reminiscent of actors performing on stage without a script, drawing inspiration from spontaneity, creativity, and intuition; this is the essence of organizational improvisation [12, 13].

The essence and purpose of organizational improvisation is to solve problems and make decisions as needed, without relying on pre-established plans; it is immediate action. This action does not come from a vacuum; it draws on existing knowledge, organizational routines, and collective memory within the organization to generate these immediate, effective,

and innovative responses to unforeseen emergencies. Therefore, the process relies on quick thinking, intuition, creativity, and expertise to achieve immediate results [12, 13].

At the point where planning meets execution, improvisation emerges, where teams use partial flexible structures that allow for minor adjustments to adapt during the work, or perhaps take bold and innovative actions[4].

Many studies, such as Weick [13]; Krusic, et al. [14] and Carrasco-Carvajal, et al. [15] have addressed the mechanism for implementing improvisation within organizations [4]. They emphasized that improvisation can be a deliberate and strategic process, not merely a reaction. It is a process built upon what the organization has learned from the past [4]. In practice, organizational improvisation is essentially about the ability of the entire organization to respond flexibly and creatively at all levels. This covers both strategic improvisation, which deals with high level choices with wider implications, and operational improvisation, which deals with ordinary tasks.

Organizational improvisation has developed into a fundamental organizational competence, according to recent studies like [16, 17].

It is more than just a crisis response tool; it is a longterm asset, an essential component of organizational culture, and a sour ce of competitive advantage that improves the organization's capacity to adjust to everyday operations rather than just emer gencies.

But according to Barrett [12] organizational improvisation's results are crucial components of creativity and organizational agility, particularly in dynamic firms. Overcoming uncertainty requires creativity, flexibility, and learning. Improvisation speeds up decision-making, fosters learning from failures, and enables teams to produce creative, adaptable, and cohesive solutions in real time.

Organizational improvisation by encouraging creativity and teamwork speeds up innovation when people have the right knowledge, resources, and support [18, 19]. Organizations must foster a culture that encourages experimentation and teach their staff to think positively to improve their capacity to produce new ideas and deal with obstacles. By allowing teams to act spontaneously rather than depending on predetermined plans, improvisation promotes resilience [13].

To promote open innovation in quickly evolving extractive industries, it is crucial to stay adaptable and responsive. Thus, using organizational agility as a moderating variable, this study attempts to create a thorough theoretical framework that explains how organizational improvisation can affect open innovation.

In the context of extractive industries, where ambiguity and unpredictability are a part of everyday operations, four fundamental principles—spontaneity, creativity, expertise, and risk-taking—were taken from earlier literature.

2.2. Spontaneity

When presented with an emergency or unforeseen circumstance, being spontaneous entails moving quickly and making snap decisions. Organizations do not have the luxury of long-term planning in high-stakes scenarios. They turn to spontaneity, which allows teams to act quickly and efficiently without being constrained by plans and bureaucracy [13, 18-24]. The significance of organizational improvisation becomes clear because extractive industries are susceptible to operational setbacks or abrupt market developments that call for quick action.

2.3. Creativity

Being creative entails producing novel and unusual solutions, particularly when confronted with fresh possibilities or challenges. When innovation is essential for long-term survival, creativity becomes a driving force for problem-solving and seizing opportunities. Improvisation involves restructuring existing knowledge in new and innovative ways. Numerous studies indicate that improvisation and creativity go hand in hand, helping organizations survive and thrive in competitive and complex environments [18, 19, 21, 23-25].

2.4. Expertise

When it comes to improvisation, experience allows teams to use lessons learned from the past to inform the present instead of depending only on intuition or guessing. According to several studies [5, 18, 20, 24, 26-28] expertise is the depth of knowledge and competence upon which employees base their prompt and deliberate decisions. Expertise is crucial in vital industries because these sectors make decisions that have significant operational and security ramifications.

2.5. Risk-Taking

Risk-taking is a willingness to act in unclear and uncertain circumstances rather than being reckless. It shows an organization's willingness to act decisively and boldly in emergency situations and under time limits, even when the outcome is uncertain [26, 29]. In the extractive industries industry, where possibilities are swift and ephemeral and reluctance can be costly, an attitude of embracing the unexpected is crucial.

These dimensions—acting swiftly, thinking creatively, utilizing learned skills, and accepting ambiguity and uncertainty—were selected because they are consistent with how improvisation functions. When taken as a whole, these dimensions offer organizations a thorough framework for implementing improvisational solutions that support their continued agility, creativity, and adaptability.

2.6. Open Innovation

Innovation is the process of taking new, unique, and creative ideas, then developing, financing, producing, and distributing them to external customers, creating value for both the organization and the consumer [30]. It is defined as the set of capabilities that enable companies to influence employee behavior and motivate them to produce new, advanced, and

implementable ideas to achieve strategic goals [31]. Innovation is the process of creating new solutions and ideas; it is the art of introducing something new, a new way, or a new device; it is a change in the way things are done; it is renewal and the provision of alternatives [32]. The concept of Open Innovation, first defined by Chesbrough [1] as the valuable ideas that can come from inside or outside the company and can go to market from inside or outside the company as well [1]. According to Marais [33]. Chesbrough later defined open innovation as a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. Open innovation characterized by diverse themes ranging from knowledge transfer and product development to emerging topics such as sustainability, artificial intelligence, and digital ecosystems [34].

There are three major challenges with open innovation: finding creative ways to exploit internal innovation, integrating external innovation into internal development and motivating outsiders to provide a steady stream of external innovations West and Gallagher [35]. Carvalho, et al. [36] emphasized the importance of investing in relational capital to foster open innovative practices and develop innovative capabilities. The key feature of open innovation is allowing ideas and knowledge in the innovation process to flow purposefully across the company's organizational boundaries, in alignment with its business model [37]. In the field of open innovation, there are numerous models that are used to design and implement innovation. These models are cornerstones for understanding open innovation and achieving a sustainable innovation process [38].

2.7. Outbound Innovation

Effective commercial marketing of internal technologies generates outbound open innovation, especially as companies continuously strive for growth and increased competitiveness. The ability to harness knowledge management capabilities is of paramount importance for open innovation, as it enables companies to identify, transfer, and commercialize their internal technologies beyond their boundaries, resulting in external open innovations [39]. The outbound open innovation model is one form of open innovation where companies make their knowledge, ideas, and technologies available externally for other parties to benefit from [40]. It indicates to the commercialization of internal knowledge and innovations that companies may not be able to fully exploit on their own. This may include establishing subsidiaries, licensing patents, or forming partnerships with other companies to leverage their innovations in new markets or applications, thereby strengthening the company's market position [41]. Outbound open innovation is manifested in several practices such as granting intellectual property licenses to market partners, making technological knowledge available for exploitation outside the boundaries of the company, and developing and enhancing the company's technological knowledge in coordination with its external environment [42].

2.8. Inbound Innovation

Companies seek to acquire new competencies and resources, often leveraging their external networks, to keep pace with rapid technological change by adopting industry technologies and technological capabilities. This enables them to engage in inbound open innovation, which is implemented through a wide range of formal and informal connections that contribute to exploring knowledge bases and experimenting with more diverse industry technologies, such as the internet of things, automated robotics, and 3D printing [43]. Inbound open innovation focuses primarily on bringing in ideas and knowledge from outside and using them [44]. It is supported through many practices, such as supporting innovation processes within companies by bringing in knowledge from external sources, and establishing strong and long-term relationships with several knowledge sources such as customers, competitors, suppliers, universities, and research centers, which exchange expertise, knowledge, and consultations, discover innovative opportunities, and work to seize them [42]. Companies are increasingly benefiting from open innovation to maximize the utilization of knowledge and external ideas in innovation processes. A wide range of practices have emerged to implement inbound innovation. Key among these are: involving external sources from users, students, suppliers or employees to propose specific innovative ideas; internally licensing of intellectual property based on prior knowledge developed outside the company's boundaries; building relationships and alliances with external partners to collaboratively develop knowledge; establishing a separate business entity with external partners to implement a joint venture; and fully integrating an external organization within the company through a merger and acquisition deal, which is considered as a practice of inbound open innovation [45].

2.9. Coupled Innovation

It means that the company combines inbound open innovation and outbound open innovation processes, so that the company presents its internal knowledge and makes it available to its partners while simultaneously acquiring knowledge and ideas from the external environment [46]. Coupled open innovation is a strategy resorted by companies to boost their business value by leveraging ideas and technologies from both internal and external sources to drive innovation. This involves exchanging ideas and knowledge between companies and external partners, as well as using internal ideas to develop new products and/or services, thereby maintaining a sustainable competitive advantage [47]. The concept of coupled open innovation refers to the bidirectional interaction between companies and innovative actors outside them, and the use of external ideas in addition to internal ideas [48]. It adopts the integration of knowledge from outside and inside companies, so that they can use internal and external knowledge and ideas, exploit this knowledge, and explore the knowledge surrounding them Carrasco-Carvajal, et al. [15]. In the coupled innovation model, internal and external aspects are connected through working in alliances with complementary companies, where give and take is essentially for success [49].

2.10. Organizational Agility

The concept of agility first emerged in the early 1990s as a response to significant changes in the external environment. Businesses needed to adapt to these rapid and multifaceted transformations, and they began to view agility to gain a competitive edge, resulting in the adoption of more responsive operating methods [7]. During the Industrial Revolution, organizations focused primarily on increasing production and internal processes. However, with the increasing changes in the external environment due to globalization and competition, the need arose for concepts more capable of addressing these new conditions. Organizational agility has become essential for adapting to rapid and continuous changes, enabling organizations to ensure swift response, control costs, and achieve the required quality, ultimately meeting customer needs [50].

Organizational agility has become a crucial factor for the growth and profitability of organizations. Agile organizations have better management capabilities, enabling them to make sound decisions and collaborate effectively with stakeholders. This, in turn, allows organizations to develop dynamic business models that align with technological advancements and evolving customer needs [51]. Organizational agility plays a crucial role in sensing changes in the external environment, enabling the organization to respond to and adapt to these changes [52]. Organizational agility enables organizations to stay connected to their changing markets by keeping up with everything that happens in the environment, which makes them more responsive to what will happen in the future [53].

Agility reflects an organization's ability to anticipate challenges early and to learn continuously. Organizational agility involves creating a culture that encourages rapid response to change, whether due to shifts in customer needs, competitors, or technologies [54]. Organizational agility comprises three key components: environmental awareness, operational flexibility, and specific performance outcomes [55].

One of the new organizational structures characterized by agility is the organic structure. The organic organizational structure allows for the easy restructuring of the organization's activities and human resources whenever the organization deems it necessary to respond to internal and external changes [56]. Agility increases an organization’s ability to respond quickly, helping it to adapt to its environment more rapidly and adjust, because it has the appropriate methods to help it respond effectively [57]. Agility also supports the organization in allocating and restructuring its resources in response to changes in its environment, and at the speed the organization desires. Possessing this capability enables the organization to transform challenges and crises into opportunities [58].

Agility fosters proactive organizational thinking, enabling the organization to keep abreast of all legal, technological, and competitive changes, and to learn from the events and challenges it encounters [59]. In addition to its contribution to maintaining the balance of the organization operating in a rapidly changing environment using organic work teams, and the increased use of modern technologies such as artificial intelligence and the internet of things [60]. Although researchers have offered various interpretations of the dimensions of agility, three dimensions have been frequently used in management literature: sensing agility, decision-making agility, and practice and application agility [61-64].

Sensing Agility: The ability to sense changes involves monitoring the organization's operating environment. These changes can represent opportunities or threats and may also signify the introduction of more advanced technologies. Organizations with high sensing agility rely on precise methods for analyzing and understanding transformations and responding appropriately to them [65]. One of the functions of sensor agility is to help the organization perform the intelligence task and gather information about competitors, thus ensuring that the organization keeps up with developments in its environment.

Decision-Making Agility indicates an organization's ability to make quick, well-informed decisions aligned with its strategy. This culture empowers executives to respond swiftly without waiting for approval from senior management. An organization's agility in decision-making enables it to adopt a decentralized approach to management, facilitates communication between different departments, and positively impacts its responsiveness [9, 10].

Practice and Application Agility refers to implementing changes across the entire organization. It also encompasses the organization's ability to manage risks, reduce costs, and introduce new technologies. Agile practices help organizations develop the skills of their employees needed to work in new ways, support innovation, and cultivate a work culture that encourages continuous improvement [10, 66].

Agile practices and applications provide organizations with the methodological framework necessary to adapt to a rapidly changing environment. By developing skills and systems, organizations can respond appropriately to evolving circumstances, manage risks and costs, and adopt new technologies that meet their customers' needs. This agility is achieved through an organization's focus on technological excellence, its readiness to implement necessary changes in its internal environment, and the re-engineering of its operational processes.

Researchers believe that organizational agility is an organization's ability to respond immediately and adapt quickly to internal and external conditions. This helps the organization understand changing customer needs and expectations, keep up with technological advancements and competitor activities, and make smart, timely decisions.

2.11. Hypotheses Development

2.11.1. Organizational Improvisation and Innovation

Improvisation has become a crucial concept for any organization considering organizational innovation, especially if it operates in a rapidly changing environment. Improvisation refers to thinking and acting on the spot, relying on experience, foresight, and available resources [20]. Organizational innovation is considered a structured process, requiring the organization to go through specific steps and adhere to certain procedures, but some assert that improvisation can generate new, out-of-the-box ideas [67, 68].

Improvisation can be viewed as a creative behavior based on combining practical experience with established standards. Kohring [69] explains that even spontaneous activities undertaken by individuals can result in innovative products when accepted by the target customer segment. Improvisation enables organizations to deliver products using limited resources in an innovative way. Improvisation requires the involvement of the target customers in this activity, thus ensuring the delivery of sustainable products.

Kohring [69] illustrates, even small, spontaneous changes by craftspeople can evolve into accepted innovations when embraced by the broader community. In organizations, this kind of on-the-fly problem-solving enables smarter use of limited resources, boosts collaboration, and involves end-users in the process—leading to more sustainable innovation [21].

Improvisation often involves a combination of necessity and enthusiasm, and when a flexible culture exists, it becomes a source of sustainable development [68]. Building improvisation skills helps in understanding new knowledge and increases the potential for innovation in challenging circumstances [70].

$H_{1:}$ Organizational improvisation has a statistically significant impact on open innovation in Jordanian Extractive and Mining Companies

2.11.2. Organizational Improvisation and Organizational Agility

An organization's operational agility is greatly influenced by organizational improvisation. The organizational improvisation concentrates on taking rapid action and suggesting solutions based on experience, agility refers to the capacity to make wise decisions and quickly adjust to the environment [6, 71]. These two components work together to assist organizations deal with complexity and ambiguity in an efficient manner.

Organizational improvisation uses impromptu thinking based on problem-solving expertise to bridge the gap between planning and implementation [72]. When management-defined plans cannot be conducted, it also helps businesses to quickly adjust. This idea views improvisation as a flexible ability that organizations can use when plans are hard to conduct. Organizations can reorganize and react quickly to address obstacles by using improvisation. **Improvisation helps** organizations restructure and respond agilely to overcome uncertainties [73]. To promote organizational agility and support innovation, organizational improvisation is essential. It emphasizes the connection between innovation and internal knowledge exchange, especially as external knowledge is frequently too general to adequately address the organization's quick rate of change [72]. Organizational improvisation promotes inter-organizational learning and the best use of new technologies in the digital world [74].

$H_{2:}$ Organizational improvisation has a statistically significant impact on organizational agility in Jordanian Extractive and Mining Companies.

2.11.3. Organizational Agility and Innovation

In the corporate sector, organizational agility and innovation are intimately related, especially in highly competitive markets. According to Teece, et al. [11] agility can be defined as an organization's capacity to reallocate its resources in response to changes in its operational environment, allowing it to take advantage of opportunities. This tendency is supported by agile project management approaches like Kanban, which place a strong emphasis on employee engagement, ongoing learning, and responsiveness to client expectations [5, 75].

Agility is based on a balance between control and agility rather than functioning in an unrestricted environment. According to Zheng, et al. [73] agility increases when businesses are flexible. This balance, called planned improvisation, allows teams to adapt quickly without losing strategic focus.

In addition to the importance of speed for organizational agility, there is also the importance of sound decision-making. When an organization has a clear vision and is open to change, the conditions are ripe for innovation. In this way, agility becomes an effective means of managing uncertainty and remaining competitive.

$H_{3:}$ Organizational agility has a statistically significant impact on open innovation in Jordanian Extractive and Mining Companies.

2.11.4. Improvisation, Organizational Agility and Innovation

An essential idea for organizational creativity and agility is organizational improvisation. By utilizing their knowledge and resources, it enables businesses to react swiftly to unanticipated events [20, 71]. By bridging the gap between planning and execution, improvisation improves organizational agility through quick response, allowing for quick adaptability to changes in the environment [6, 72]. Organizational improvisation also represents a dynamic capability, assembling resources innovatively to support processes and propose new solutions [70, 73]. Furthermore, organizational agility plays a critical role in supporting innovation by facilitating rapid process reconfiguration, effective responses to changing conditions, and the application of flexible approaches that foster learning and collaboration [5]**.** Studies indicate that the relationship between agility and innovation flourishes when supported by improvisational leadership capable of managing stress and making creative decision [73, 74]**.** Therefore, integrating organizational improvisation and organizational agility creates favorable conditions for long-term innovation and adaptation in unstable and dynamic environments.

H4: Organizational agility mediates the relationship between organizational improvisation and open innovation in Jordanian Extractive and Mining Companies.

3. Methodology

3.1. Sample

The researchers contacted the management of 16 Jordanian mining and extraction companies and obtained their consent to collect the necessary data for the study. The study population consisted of 1,700 managers across these companies. The researchers encouraged participants to provide data which helped in collecting the required number of questionnaires. The study sample size was 313 managers, to whom the questionnaires were distributed electronically through organized visits by researchers. A total of 286 questionnaires were returned and analyzed using SmartPLS 4.

3.2. Measurement

The survey aims to measure organizational improvisation through four dimensions: spontaneity, creativity, expertise, and risk-taking.

The measurement tool used in this study was constructed based on a combination of 19 items drawn from previous literature and newly developed items. The dimensions of creativity and risk-taking were adapted from prior studies that examined these aspects in the context of OI [18, 76, 77].

The items on spontaneity and expertise were developed after a review of the literature on these two dimensions.

Open innovation was measured using a three-dimensional scale that has been adopted in many studies in this field (outbound innovation, inbound innovation, and coupled innovation) [35-38]. 14 items were developed based on questionnaires in previous studies, which have proven to have high reliability [46, 78, 79].

Regarding organizational agility, 9 items were adopted to cover a scale consisting of its three dimensions, based on previous studies in this field [80-83].

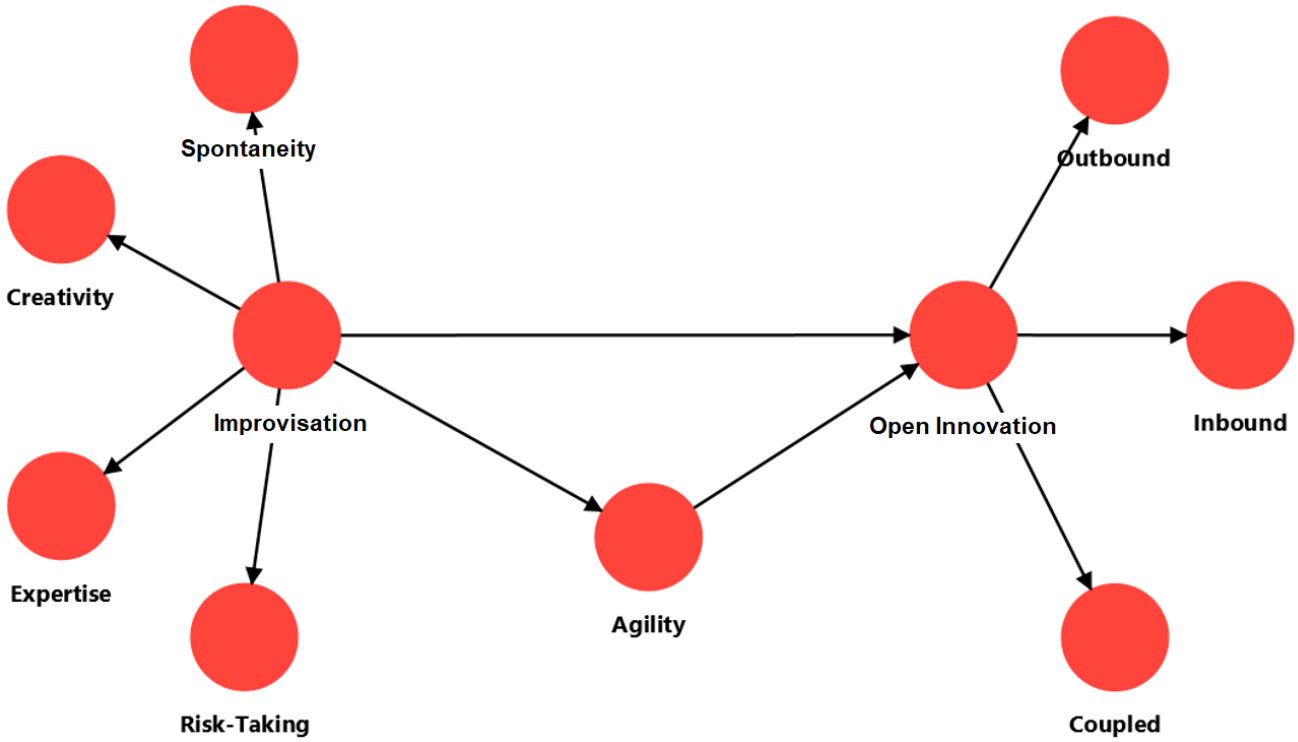

Figure 1.
Study Model.

3.3. Measurement Model

The measurement model was assessed for reliability and validity (Convergent Validity and Discriminant Validity). Results are represented in Table 1 and Figure 2. Outer loadings, Cronbach's alpha, and Composite Reliability (rho_and rho_c) were used to examine the reliability of the model, while the Average Variance Extracted (AVE) was used to assess the convergent validity and Fornell-Larcker criterion was used to assess the discriminator validity of the model. Outer loadings for all items were over the threshold of 0.7 and Cronbach's alpha values were over the value of 0.7 [84]. Composite reliability for all constructiowasere higher than the value 0.6 [84]. Moreover, AVE values were higher than 0.5 [84].

Table 1.
Measurement Model.

construct	Indicator	Outer loadings ≥ 0.7	Cronbach's Alpha ≥ 0.7	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE ≥0.5
Spontaneity	Spon1	0.795	0.841	0.841	0.887	0.611
	Spon2	0.782				
	Spon3	0.787				
	Spon4	0.788				
	Spon5	0.757				
Creativity	Creat1	0.802	0.871	0.871	0.906	0.660
	Creat2	0.817				
	Creat3	0.788				
	Creat4	0.817				
	Creat5	0.836				
Expertise	Exp1	0.812	0.864	0.865	0.902	0.649
	Exp2	0.772				
	Exp3	0.801				
	Exp4	0.806				
	Exp5	0.835				
Risk-Taking	Risk1	0.909	0.792	0.919	0.799	0.500
	Risk2	0.896				
	Risk3	0.728				
Outbound Innovation	Outb1	0.805	0.871	0.872	0.907	0.660
	Outb2	0.793				
	Outb3	0.818				
	Outb4	0.831				
	Outb5	0.816				
Inbound Innovation	Inb1	0.832	0.883	0.883	0.914	0.681
	Inb2	0.823				
	Inb3	0.801				
	Inb4	0.856				
	Inb5	0.813				
Coupled Innovation	Coupled1	0.873	0.845	0.880	0.890	0.621
	Coupled2	0.799				
	Coupled3	0.905				
	Coupled4	0.728				
Organizational Agility	Agility1	0.775	0.905	0.908	0.927	0.712
	Agility2	0.795				
	Agility3	0.871				
	Agility4	0.859				
	Agility5	0.885				
	Agility6	0.831				
	Agility7	0.853				
	Agility8	0.868				
	Agility9	0.848				

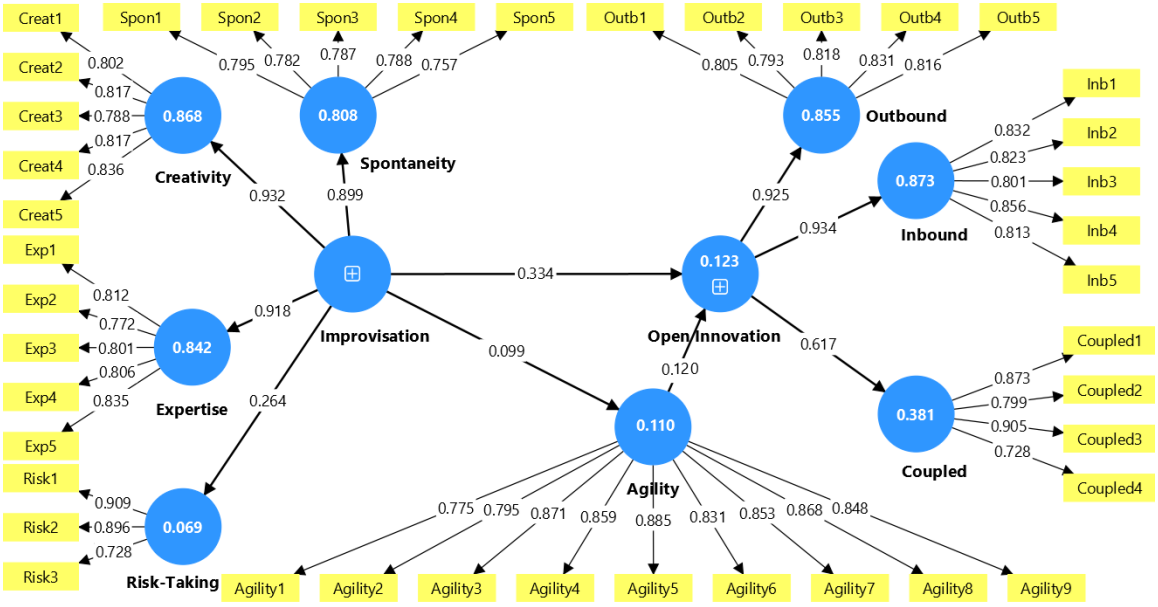

Figure 2.
Measurement Model.

Table 2 shows the Fornell-Larcker matrix. The square roots were highlighted in bold along the matrix diagonally, since based on the Fornell-Larcker criterion outcome evaluation can be determined whether the squared correlation of each variable (AVE) is greater than any squared correlation with another construct. All coefficients according to this criterion were acceptable, confirming discriminant validity.
Reliability and validity were confirmed based on these criteria.

Table 2.
Discriminant Validity.

	Coupled Innovation	Creativity	Expertise	Inbound Innovation	Outbound Innovation	Risk-Taking	Spontaneity
Coupled Innovation	**0.788**						
Creativity	0.067	**0.812**					
Expertise	0.014	0.796	**0.805**				
Inbound Innovation	0.388	0.296	0.355	**0.825**			
Outbound Innovation	0.364	0.322	0.382	0.836	**0.813**		
Risk-Taking	0.493	0.216	0.121	0.003	0.000	**0.682**	
Spontaneity	0.045	0.758	0.744	0.305	0.340	0.161	**0.782**

3.4. Structural Model

After confirming the reliability and validity of the measurement model, the structural model was examined using Variance Inflation Factor (VIF), determination coefficient (R^2), predictive relevance ($Q^2_{Predict}$), and path Coefficients (β). Table 3 shows the values of multicollinearity between the study variables, where independent variables are represented by rows and dependent variables by columns. All Variance Inflation Factor (VIF) values are less than 5 [84] meeting the accepted criterion. This indicates that there are no critical levels of multicollinearity among the study variables, and the structural model evaluation can therefore proceed.

Table 3.
Collinearity Statistics (VIF).

	Organizational Improvisation	Organizational Agility
Open Innovation	1.010	1.010
Organizational Agility	1.000	

For the determination coefficient, the R^2 value for the dependent variable represented by organizational improvisation is 0.123, means that organizational improvisation and organizational agility explain 12.3% of the variance in open innovation. Furthermore, organizational improvisation explains 11.0% of the variance in organizational agility. According to Hair, et al. [84] it can be concluded that organizational agility partially mediates the relationship. A blindfolding method was used to examine predictive relevance using $Q^2_{predict}$ values, values greater than zero indicate that the model has good

predictive relevance [84]. Therefore, this model has good predictive relevance, since the Q^2 predict values were 0.640 and 0.002 for organizational improvisation and organizational agility, respectively. In terms of the path coefficient (β), the model was tested using 5000 samples bootstrapping. Results are shown in Table 4 and Figure 3. Organizational improvisation has a positive impact on open innovation (β = 0.334, p =0.000< 0.05), confirming H_1. Organizational improvisation has a positive impact on organizational agility (β = 0.099, p =0.004< 0.05), confirming H_2. Organizational agility has a positive impact on open innovation (β = 0.120, p =0.041< 0.05), confirming H_3.

Organizational agility has a positive partial impact as a mediating variable in explaining the impact of organizational improvisation on open innovation (β = 0.012, p=0.000< 0.05), confirming H4.

Table 4.
Testing Hypotheses.

Hypothesis	Path	Path coefficient (β)	*t*-Value	*p*-value	Sig p≤0.05
H_1	Organizational Improvisation → Open Innovation	0.334	5.255	0.000	Yes
H_2	Organizational Improvisation → Organizational Agility	0.099	3.621	0.004	Yes
H_3	Organizational Agility → Open Innovation	0.120	4.653	0.041	Yes
H_4	Organizational Improvisation → Organizational Agility→ Open Innovation				Yes
	Direct effect	0.334	5.255	0.000	Yes
	Indirect effect	0.012	2.048	0.000	Yes
	Total effect	0.346	5.928	0.000	Yes

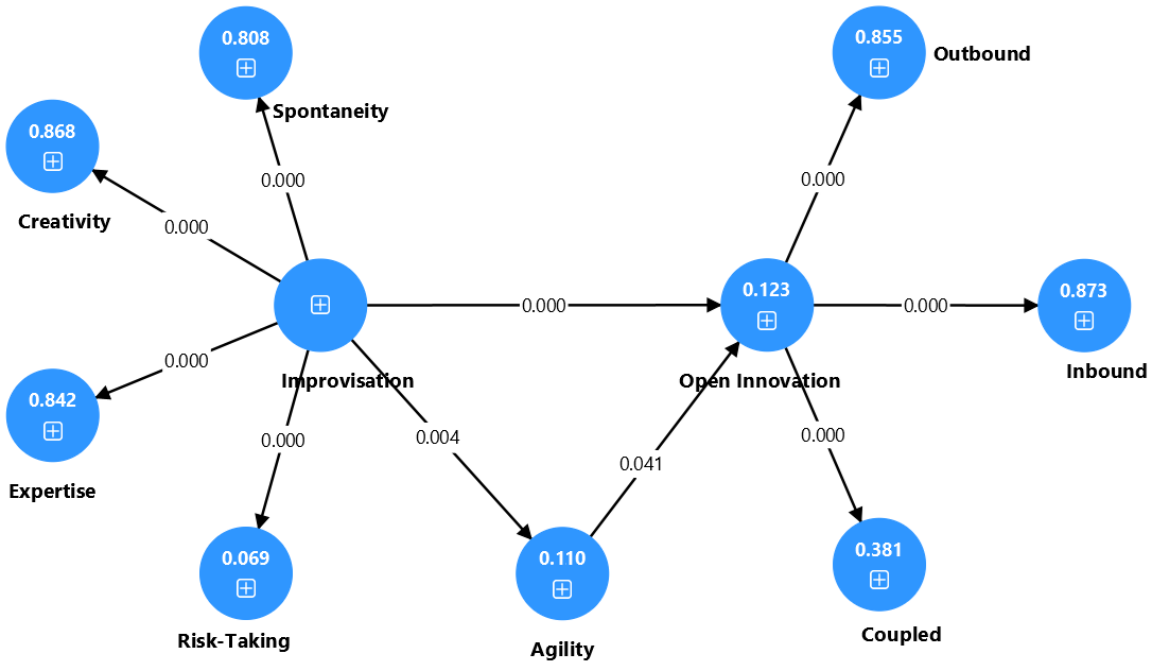

Figure 3.
Hypotheses Testing (*p*-value).

4. Discussion and Conclusions

This study discusses the relationship between organizational improvisation and open innovation and examines the mediating impact of organizational agility on this relationship in Jordanian mining and extraction companies. This study used spontaneity, creativity, expertise, and risk tolerance as dimensions of organizational improvisation, while internal, external, and coupled innovation were used as dimensions of open innovation. The findings of this study contribute to a deeper understanding of organizational improvisation, open innovation, and organizational agility. This study examines the direct impact of organizational improvisation on open innovation and how organizational improvisation indirectly influences open innovation through organizational agility. Taken together, this study provides valuable evidence in the context of mining and extraction companies in Jordan, a developing country. SPSS24 and SmartPLS3 were used to process the data, create the explanatory model, conduct the analysis, and validate the multilevel influence mechanism of organizational improvisation on open innovation with agility as a mediating variable. The results of this field study are as follows:

4.1. First: The Relationship between Organizational Improvisation and Open Innovation

The study results showed that organizational improvisation significantly impacts open innovation. The company's use of technological innovations to deliver its services in an innovative manner enabled it to sell all technologies to external companies for external marketing purposes. The company's adoption of innovative solutions to problems facing the business environment contributed to signing cooperation agreements with various business organizations and building strategic alliances with other companies. The company's ability to act quickly without relying on pre-planned solutions in some emergency situations helped it leverage technology and information generated outside the company in conjunction with its research and development and utilize external resources to complement its own R&D, such as research organizations, universities, suppliers, customers, and competitors. The company's ability to leverage past lessons also enabled it to devise appropriate solutions during sudden crises and select appropriate joint projects with other business organizations. It also encouraged the company to make potentially risky decisions in purchasing information technology systems, technologies, and modern software for use in its operations, thereby improving performance. While the company's cumulative knowledge has contributed to the development of improvised responses, it has also been able to secure external investment in its intellectual property, as well as market its internal technologies that are not being used internally. The company's continuous scanning of the external environment for new inputs of ideas, knowledge, and information has enhanced its ability to obtain technology, patents, and licenses from other companies, research institutions, and academic institutions.

4.2. Second: The Relationship between Organizational Improvisation and Agility

The results indicate that organizational improvisation significantly impacts organizational agility. It enabled managers to draw upon their experience in handling emergencies and responding to them immediately. The company's belief in the importance of outsourcing its research and development to supplement its own research and development (R&D), such as research organizations, universities, suppliers, customers, and competitors, enabled it to possess a database that aids decision-making and provides an information system that enables managers to make quick decisions. Encouraging the company to make potentially risky decisions if they have the potential to improve performance has also contributed to the timely restructuring of operations and the prompt response to customer problems. The company's use of technological innovations to deliver its services in an innovative manner enabled it to respond to customer problems promptly. While the company's ability to respond quickly to sudden changes without the need for lengthy referrals through the management hierarchy has enhanced the company's organizational structure's flexibility in the face of change.

4.3. Third: The Mediating Role of Organizational Agility

The study results showed that agility mediates the relationship between organizational improvisation and open innovation. The company's ability to keep pace with changes in technology and its interest in environmental scanning to identify available opportunities helped it build strategic alliances with other companies and utilize technology and information generated externally in conjunction with its research and development, as well as purchase modern IT systems, technologies, and software. Finally, the company's interest in environmental scanning to identify available opportunities enabled it to research and access technology, patents, and licenses from other companies, research institutions, or academic institutions. The company also leveraged every possible external use of its intellectual property to benefit from it.

4.3.1. Theoretical Implications

The findings of this study can be applied to numerous management scenarios. The study model includes an analysis of the relationship between organizational improvisation, open innovation, and organizational agility. Furthermore, the results help bridge the theoretical gap concerning these variables. The study offers new insights into the growing interest of organizations in organizational improvisation and agility. Specifically, the study's findings demonstrate the vital role of spontaneous organizational improvisation practices, creativity, expertise, and risk-taking in promoting open innovation, both directly and indirectly through organizational agility. This finding confirms recent management propositions that organizational improvisation is often best understood by considering various organizational aspects together—rather than focusing on effects at a single level. Thus, the study's findings confirm that organizational improvisation is a multi-level perspective and emphasize the fact that individuals at all levels within an organization play a role in organizational improvisation. In terms of the context of applying the topic of organizational improvisation, agility, and open innovation, this study places these topics within the context of Jordanian mining and extraction companies—a suitable, knowledge-intensive model environment in a developing country—to validate the positive impact of the study's model of four-dimensional organizational improvisation on three-dimensional open innovation, and to reveal the mediating effect of organizational agility. This not only supports these variables and their relationships across previous studies in Western contexts but also enriches their underlying mechanisms in other contexts in developing countries, providing empirical evidence for the application and localization of the theory (so to speak) of organizational improvisation and placing it in its correct and ideal contexts.

Another theoretical contribution of the study's findings is the addition of nuance to the study of the impact of organizational improvisation on open innovation through organizational agility. Accordingly, this issue represents an important contribution, as this research deepens the understanding of organizational agility, clarifying its essential function as a mediator between organizational improvisation and open innovation. The mediating impact of organizational agility is theoretically intriguing, supporting the notion that organizations adopting an organizational improvisation approach to open innovation should possess organizational agility. The findings also contribute to a new understanding of the impact of

organizational agility on the relationship between organizational improvisation and open innovation. To the best of the researchers' knowledge, this is the first study to examine organizational agility in relation to organizational improvisation and open innovation.

4.3.2. Practical Implications

The findings of this study offer practical insights into the elements of organizational improvisation in Jordan's mining and extraction sector. These insights constitute essential guidelines for organizations seeking to leverage organizational improvisation and its various components as effective tools for enhancing agility and fostering open innovation. The study identifies four key dimensions of organizational improvisation: spontaneity, creativity, experience, and risk tolerance. Therefore, organizations should focus on these elements to achieve agility and stimulate open innovation. The study offers several recommendations for enhancing the elements of organizational improvisation, including attracting talent, mentoring and supporting all individuals at all levels through a clear culture, providing opportunities for everyone to work in teams, and empowering these teams. Employees should also be involved in defining overall organizational strategies, ensuring that their feedback is considered to improve company strategies and motivate employees.

To cultivate a culture of open innovation, organizations must foster an enabling environment that encourages employees to seek opportunities by motivating individuals to innovate and exploring diverse innovative tools and methods. Companies must also recognize that open innovation is not limited to senior management; it is a valuable resource for acquiring external knowledge. Companies should develop open innovation strategies that enable them to generate new ideas through external partnerships and alliances.

Companies seeking to navigate uncertainty must be agile and responsive to change. This requires using business models that enable organizations to adapt rapidly. Organizations must understand that agility relies on two essential elements: dynamism, the ability to move quickly—and stability—a strong foundation of constant elements within the organization. The foundations and principles for achieving agility must be laid by structuring the organization in a way that considers both stability and dynamism.

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