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The Impact of Intellectual Capital on Production Flexibility at Dubai Pharma / Samarra

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Abstract

This study aimed to investigate the impact of intellectual capital, represented by its dimensions of human capital, relational capital, and structural capital, on enhancing production flexibility with its various dimensions, including machine flexibility, new product introduction flexibility, and human resource flexibility, through an applied study at Dubai Pharmaceutical Industries Company. The main objective of the study was to analyze the nature of the relationship between intellectual capital and the organization's ability to adapt to operational and production changes, as well as to determine the extent to which each dimension of intellectual capital contributes to enhancing production flexibility within the company. The descriptive analytical approach was adopted because it is suitable for the nature and objectives of the research. This approach helps in describing phenomena and analyzing relationships among variables scientifically and systematically. The study population included all employees working at Dubai Pharmaceutical Industries Company located in Samarra, Salah Al-Din Governorate, Iraq - a total of (101) employees. Since this is a relatively small study population, the comprehensive survey method (Census Method) was used to represent fully all members of the population and achieve more accuracy in results. However, (22) questionnaires were excluded due to incomplete data or inconsistencies that would affect the validity of statistical analysis. Therefore, valid questionnaires for analysis came down to (79), with a response rate of 78.2%. The results of the study showed a statistically significant positive effect of intellectual capital on production flexibility at the significance level ($\alpha \leq 0.05$). Results also indicated that intellectual capital has a significant effect on all dimensions of production flexibility, i.e., machine flexibility, new product introduction flexibility, and human resource flexibility.

Keywords: Intellectual Capital, Production Flexibility, Dubai Pharma, Samarra, Iraq.

Highlights

- The study investigates the effect of intellectual capital on production flexibility at Dubai Pharmaceutical Industries in Samarra, Iraq.
- Data were analyzed from 79 valid questionnaires, representing a 78.2% response rate from the total study population.
- PLS-SEM results confirmed a significant positive effect of intellectual capital on production flexibility ($\beta = 0.709$, $t = 25.200$, $p < 0.001$).
- Intellectual capital had the strongest effect on new product introduction flexibility ($\beta = 0.663$), followed by human resource flexibility and machine flexibility.

1. Introduction

The present age is witnessing rapid transformations in the commercial landscape as a result of globalization, technological progress, heightened competition, and rising expectations for sustainability. This has led organizations to look for unusual sources to create a unique identity and respond swiftly to alterations. In this situation, intellectual capital has come forth as one of the most critical intangible strategic assets on which organizations depend to improve their competitiveness and obtain sustainable growth. Recent literature has validated that the elements of intellectual capital—human, structural, and relational capital—play an essential role in enhancing performance, growth, and innovation capacity in small and medium-sized enterprises (SMEs) [1].

Studies show that intellectual capital influences more than just financial outcomes by enhancing entrepreneurial orientation, competitive flexibility, and the capability to identify and act on entrepreneurial opportunities [2]; [3]. Reviews of literature have also pointed out that the systematic measurement and disclosure of intellectual capital is very important in realizing its actual value to support strategic performance [4]. Recent studies have similarly validated that investing in green intellectual capital enhances corporate image and attains a sustainable competitive advantage [5], while its value is reflected in improved competitiveness and financial sustainability for organizations [6].

Flexibility in production has become a key topic within contemporary operations management. This flexibility encompasses an entity's capacity to adjust to fluctuations in demand, alterations in product assortment, and effective redistribution of assets. Flexibility within production systems improves both productivity and agility under the conditions that come with Industry 4.0 [7]. Flexible information systems and supply chains play a mediating role in improving operational performance [8]. Recent research has focused on the theoretical side of production flexibility and its relationship with capital rigidity [9], as well as supplier relationship management flexibility and its effects on performance [10].

Flexibility is also a concept that has been introduced in the fields of energy and green transitions. Research has shown how important operational flexibility can be in making industrial systems that rely on hydrogen and renewable energy economically viable [11]; [12]; [13]. This mirrors the fact that flexibility has a strategic character as an important element for sustainability within production systems.

By linking these two concepts, it becomes evident that intellectual capital constitutes the knowledge, organizational, and relational basis upon which an organization can achieve elevated levels of production flexibility. Knowledge and experience accumulated over time serve to enhance system adaptability, while an innovative culture fosters the development of new products. Relationships with suppliers and partners help to reduce response times and increase the flexibility of supply chains [14]; [15]. In addition, the leadership literature affirms that entrepreneurial traits and opportunity identification are closely related to strong intellectual capital [16]; [17], as well as that individual values and attitudes are a major determinant of innovative behavior in organizations [18].

This study starts with the main idea that smart investment in intellectual capital is a strategic way to improve productive flexibility and, as a result, gain a long-lasting competitive edge in today's industrial settings. This is based on what recent literature in intellectual capital and operations management has confirmed.

1.1. Problem of Research:

Due to the fast changes in the industrial business world with technology, laws, and competition, production companies must improve their ability to react quickly to demand changes, modernize their production lines, and create new products effectively. Production flexibility has many aspects (machine flexibility, new product introduction flexibility, and human resource flexibility), which is one of the key signs showing how well an organization can survive and grow in a changing environment [7]; [8].

On the other hand, recent literature suggests that intellectual capital is an important strategic resource in enhancing organizational performance, innovation, and entrepreneurial orientation [1]; [19]; [20]. Additional studies confirm that the components of intellectual capital enhance competitive agility, the ability to seize opportunities, and a sustainable competitive advantage [2]; [6]; [21].

In spite of this research wave, most of the past studies have looked at the link between intellectual capital and either financial performance, innovative performance, or entrepreneurial performance. The link between intellectual capital and productive flexibility has not been given enough attention especially in the context of the pharmaceutical industry in developing countries. Moreover, studies on productive flexibility have largely centered around technical or operational dimensions without a systematic effort to relate these to intangible knowledge assets such as human, structural, and relational capital [9]; [10].

The research problem is represented by the knowledge gap in the extent to which intellectual capital contributes to enhancing productive flexibility in its dimensions and the degree to which the strength of this impact varies among the three dimensions of intellectual capital. A sub-question is whether organizations are investing their knowledge resources in such a way that truly enables them to achieve operational and strategic flexibility or whether there is a deficiency in using these resources to respond effectively to changes in the environment. Therefore, the study problem can be formulated through the following main question:

What effect does intellectual capital have through its different dimensions (human, structural, and relational) on attaining productive flexibility in its aspects (machine flexibility, new product introduction flexibility, and human resource flexibility)?

This primary inquiry gives rise to several secondary questions:

1. What is the level of availability of intellectual capital in its various dimensions within the organization under study?
2. What is the level of productive flexibility in its three dimensions?
3. Is there a statistically significant correlation between intellectual capital and productive flexibility?
4. What is the nature of the influence exerted by each dimension of intellectual capital on each dimension of productive flexibility?

1.2. Importance of the Research:

This study is important in terms of empirical research, as it looks at two very important ideas that people have been studying more and more in the recent past: intellectual capital and productive flexibility. An empirical analysis is undertaken in an attempt to merge these constructs within a unified framework.

1.2.1. Theoretical Importance:

The study has theoretical importance as it attempts to fill a specific research gap. There have been very few direct studies on the relationship between intellectual capital and productive flexibility. This is rather surprising because many studies have been conducted on the impact of intellectual capital on growth, performance, and innovation. Thus, this study seeks to broaden the existing literature on intellectual capital by focusing on a key operational aspect: productive flexibility. This aspect is defined as an important organizational capability in today's industrial settings.

The theoretical significance of the study is to push forward the integration between a resource perspective that considers intellectual capital as an intangible strategic resource, and a dynamic capabilities perspective that sees productive flexibility as an organizational capacity for adaptation and restructuring. Recent literature supports the view that components of intellectual capital build entrepreneurial orientation, innovative capacity, and competitive agility. However, how these resources transform into operational flexibility has not been much studied. This study will try to clarify it through an analytical model linking the three dimensions of intellectual capital with dimensions of productive flexibility.

The theoretical contribution is also in enriching the operations management literature. This has mostly looked at flexibility from a purely technical or structural point of view by introducing the cognitive dimension as a reason for the ability to change production lines, speed up new product development, and increase human resource flexibility. Thus, this study presents a comprehensive conceptual framework for use in future research across various industries and contexts.

1.2.2. Applied Importance:

This study has practical importance because it provides management with a clear understanding of how intellectual capital can be applied to improve productive flexibility. In a world of mounting competition and where market conditions change by the minute, flexibility ensures sustainability and growth — and mere investment in physical assets won't lead to operational excellence. The research shows that enhancing human capital, reinforcing the organizational structure, and establishing strategic ties with partners and suppliers are indeed practical means of improving operational flexibility.

In addition, the findings of the study help decision-makers in determining where to focus their knowledge investment by indicating which aspects of intellectual capital have the greatest impact on machine flexibility, new product introduction flexibility, or human resource flexibility. This will help in designing effective training policies and establishing flexible information systems as well as promoting an innovative culture within the organization.

In addition, the study provides an empirical basis for improving sustainable competitiveness since the literature on intellectual capital investment has established a positive relationship with performance and sustainability. Therefore, the application of this study's results would enhance operational efficiency, speed up responses to environmental changes and lower operational risks, thereby consolidating the organization's position in a highly dynamic and complex industrial context.

1.3. Objectives of the Research:

This study aims primarily to assess the effect of intellectual capital (human capital, relational capital, and structural capital) on production flexibility in its several forms (machine flexibility, new product introduction flexibility, and human resource flexibility) at Dubai Pharmaceutical Industries/Samarra. More specifically, the study seeks to:

1. Assess how intellectual capital, including human capital, relational capital, and structural capital, influences machine flexibility within the Dubai Pharmaceutical Industries.
2. Investigate the impact of intellectual capital (human capital, relational capital, and structural capital) on new product introduction flexibility at Dubai Pharmaceutical Industries.
3. Analyze the impact of intellectual capital (human capital, relational capital, and structural capital) on human resource flexibility at Dubai Pharmaceutical Industries.

1.4. Hypotheses of the Research:

This study will test the following main null hypothesis:

$H_0 1$: Intellectual capital (human capital, relational capital, structural capital) has no statistically significant effect on production flexibility and its dimensions (hardware flexibility, new product flexibility, and human resource flexibility) at Dubai Pharmaceutical Industries.

The following sub-hypotheses stem from this main hypothesis:

$H_0 1$-1: Components of intellectual capital do not significantly affect the flexibility of equipment at Dubai Pharmaceutical Industries.

$H_0 1$-2: Components of intellectual capital do not significantly affect the flexibility for introducing new products at Dubai Pharmaceutical Industries.

$H_0 1$-3: Components of intellectual capital do not significantly impact the flexibility regarding human resources at Dubai Pharmaceutical Industries.

2. Theoretical Framework

The study's variable relationships are premised on intellectual capital and its three main components: human capital, relational capital, and structural capital. It is assumed that the following components influence basic productive flexibility, namely machine flexibility, new product introduction flexibility, and human resource flexibility within organizations.

2.1. The Relationship between Intellectual Capital and Productive Flexibility:

The relationship between knowledge assets and productive adaptability is strategic, as it entails the transformation of intangible knowledge resources into dynamic operational capabilities that enable the firm to respond to changes in the environment, technology, and market. Current literature sees intellectual capital as a stock of knowledge, experience, relationships, and systems; productive flexibility is viewed as an organizational ability to quickly and effectively reconfigure processes and resources in reaction to changes [7]; [9].

- First, at the human capital level, studies confirm that the skills, experience, and ability to learn continuously of employees are basic to fostering innovation and adaptability of the organization [3]; [19]. Multi-skilled employees help in reducing changeover time between processes and improving machine utilization efficiency as well as accelerating new product development. Thus, this relationship is defined whereby individual knowledge translates into operational flexibility.
- Second, structural capital—comprising systems, procedures, databases, and work culture—enables an organization to efficiently restructure its operations. Effective information systems and flexible organizational structures enhance the ability to coordinate and make rapid decisions, which positively impacts machine flexibility and the agility of new product introduction [8].

Furthermore, an internal organization that supports innovation helps transform ideas into actionable, productive applications.

- Third, relational capital plays a crucial role in supporting flexibility through relationships with suppliers, customers, and partners. Strong collaborative relationships facilitate timely access to raw materials and spare parts, and support the exchange of knowledge and expertise, thereby enhancing the ability to respond quickly to changes in demand [10]. Strategic partnerships also contribute to accelerating joint product development.

The relationship between these two variables is explained through the dynamic resource and capability theory. Intellectual capital is a scarce and difficult-to-replicate strategic resource, while productive flexibility represents an organizational capacity as a result of effective utilization of this resource. Some studies have proven that organizations investing in intellectual capital achieve higher levels of agility and competitiveness [1]; [21].

Therefore, intellectual capital and productive flexibility are directly complementary. As more knowledge assets are invested in and developed, an organization will be better able to alter its processes, initiate new products, and effectively reassign its human resources. Such responsiveness to changes in the competitive environment eventually leads to sustainable advantages for organizations.

2.2. The Relationship between Intellectual Capital and the Dimensions of Productive Flexibility:

Intellectual capital is aligned with the dimensions of productive flexibility. It is the knowledge resource that enables an organization to develop flexible and adaptable operational capabilities. Each dimension of intellectual capital (human, structural, and relational) contributes to enhancing the dimensions of productive flexibility (machine flexibility, new product introduction flexibility, and human resource flexibility) to varying degrees within the framework of dynamic resource and capacity theory.

Human capital is the knowledge base of an organization in terms of the skills, experience, and learning and innovation capabilities of its employees. These capabilities are reflected in machine flexibility by improving operational and maintenance efficiency and reducing downtime or in new product introduction flexibility by accelerating research and development processes or improving the ability to modify production structures or processes. In addition, human capital is the most influential factor in human resource flexibility due to its relationship with multi-skilled individuals, task diversity, and operational change adaptability. Employee skills development and knowledge sharing have been shown to improve innovative performance and adaptability [3]; [19].

Structural capital includes systems, procedures, databases, and organizational culture. It is related to machine flexibility in the form of documented preventive maintenance systems and production information systems that allow for quick decision-making. It also enhances the new product introduction flexibility through flexible organizational structures and clear procedures for product development and approval. As for flexibility in human resources, it is the organizational policies that favor learning, delegation, and empowering employees that allow for an efficient redistribution of tasks. The literature points out that the structure of an organization and its systems for sharing information are crucial in increasing the flexibility of both processes and supply chains [8].

Relational capital is associated with the network of relationships with suppliers, customers, partners, and regulatory bodies. Its relationship with machine flexibility is seen in guaranteeing the rapid availability of raw materials and spare parts, thus avoiding production bottlenecks. It helps create flexibility for new products through joint research and development and reacting to what the market needs. When it comes to human resource flexibility, training partnerships and sharing knowledge enhance the growth of employee skills. Solid collaborative relationships back up performance and flexibility in the buyer-supplier connection [10].

The components of intellectual capital do not act in isolation, but rather in synergy to create an additive effect on productive flexibility. Individual knowledge (human capital) requires supporting systems (structural capital) and strong external relationships (relational capital) to be transformed into a flexible operational capability. The literature indicates that equal investment in the dimensions of intellectual capital enhances competitive agility and sustainable performance [1]; [21].

The relationship between intellectual capital and the dimensions of productive flexibility is positive, and multi-dimensional in nature. Each component of intellectual capital contributes to the enhancement of one or several dimensions of flexibility. This effect is magnified when these elements are integrated within an organizational system that fosters innovation and continuous learning.

3. Methodology

The present study used the descriptive-analytical approach in examining how intellectual capital, which comprises human, relational, and structural capital, influences production flexibility in its dimensions such as machine flexibility, new product introduction flexibility, and human resource flexibility at Dubai Pharma Industries. This study uses a descriptive-analytical approach because it aims to analyze relationships between variables and describe current trends and behaviors systematically and scientifically.

3.1. Study Population and Sample:

The study included all workers at Dubai Pharma Industries located in Samarra, Salah al-Din Governorate, Iraq. There were (101) professional employees. This figure came from administrative data for the fiscal year (2025) and facts posted on the company's official website (https://dubai-pharma.co). It also shows how big the company is in terms of industrial activity and the different jobs related to production, administration, and marketing.

Because the number of people in the study was small, a census method was used. This meant that all members of the population were included, and there was no need to use a sampling method. This approach aimed to achieve a higher degree of accuracy and representativeness. (101) questionnaires were distributed to all employees, of which (22) were excluded as they were not fit for statistical analysis because of missing information, mistakes, or contradictions in the answers that might interfere with the truth of the results. Thus, the number of questionnaires valid for analysis reached (79) questionnaires, with a response rate of (78.2%) of the total questionnaires distributed, which is a high percentage that reflects a good level of cooperation from members of the community, and contributes to enhancing the reliability of the results and the possibility of generalizing them to the study community.

3.2. Validity and Reliability of the Study Instrument:

The researchers made sure that the study tool (the questionnaire) accurately and objectively measured the variables in question and was appropriate for testing the hypotheses of the study.

This was done through these validity and reliability checks:

3.2.1. Validity:

To ensure the validity of the content, it was handed out to a number of professors and academic specialists from different Iraqi universities in business administration, productivity flexibility, and intellectual capital who evaluated whether the items were suitable for measuring the dimensions of the principal variables: human capital, relational capital, structural capital, machine flexibility, new product introduction flexibility, and human resource flexibility. Modifications were made according to their comments in order to guarantee comprehensiveness and accuracy.

3.2.2. Reliability:

To measure the reliability of the research instrument, Cronbach's alpha coefficient was used to measure the internal consistency of the items for each variable, i.e., the degree of correlation between items measuring the same dimension. A scale is considered acceptable for scientific research purposes if its alpha coefficient is 0.70 or higher, as noted by [22].

The analysis results revealed that the values of the Cronbach's alpha coefficient for all study variables were within statistically acceptable limits. This means that the instrument has a very high degree of internal consistency and can be used reliably for any statistical analysis or hypothesis testing.

Table (1) Internal Consistency Coefficient (Cronbach’s Alpha)

Variable	Reliability Coefficient (Cronbach’s Alpha)
Human Capital	0.803
Relational Capital	0.856
Structural Capital	0.842
Hardware Flexibility	0.761
New Product Delivery Flexibility	0.839
Human Resource Flexibility	0.801
All Items	0.766

As per table (1), it is evident that all the variables in this study have a high degree of internal reliability based on the Cronbach's Alpha coefficient. The individual study variable values range from 0.761 to 0.842, while the overall reliability coefficient for all items was 0.766. These values imply that there is a high correlation between questionnaire items and an accurate measurement of the conceptual structure of intended variables. Hence, we can ascertain that this questionnaire shall be fit for use in any statistical analysis concerning hypothesis testing since all such values exceed the generally accepted threshold of 0.70 in scientific studies. The overall reliability coefficient further indicates very high reliability for this questionnaire as a whole, thereby supporting accurate results and conclusions regarding any statistical analysis conducted thereon.

3.3. Item Descriptive Analysis:

Table (2) presents the descriptive statistics of the sample pertaining to the study variables. Specifically, mean scores, standard deviation, minimum and maximum values for each item are provided in order to indicate how data is spread out and varied across all the variables of this study.

This descriptive analysis is primarily used to check how much variation exists in the data and whether it conforms to the proposed theories. It also assesses whether responses provided by members of the sample regarding different dimensions of each variable are consistent before moving on to an inferential analysis that statistically tests hypotheses.

3.3.1. Independent variable: Intellectual capital:

Table (2): Mean and Standard Deviation of Independent Variables (Intellectual Capital)

Dimension	Mean	Standard Deviation
Human Capital	3.83	0.75
Relational Capital	3.86	0.67
Structural Capital	4.35	0.44
Overall Variable	4.01	–

Table (2) shows that the dimensions of intellectual capital were rated high based on mean responses on a five-point Likert scale. The mean rating for this variable is 4.01, which indicates that respondents perceived substantial investment by the company in knowledge resources as well as organizational and cognitive capabilities. Among them, structural capital has received the highest mean score at 4.35 with a low standard deviation of 0.44. This demonstrates a high level of consensus among the respondents about the company's organization, internal systems, and procedures to support production and innovation processes.

Human capital and relational capital were rated relatively highly, with mean values of 3.83 and 3.86, and standard deviations of 0.75 and 0.67, respectively. This relative variation is an indication of the assessment of individual capabilities, experiences, and relationships with partners and suppliers. The variation emphasizes the need for improvement in certain areas related to employee development as

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well as strategic relationship building to enhance the efficiency of intellectual capital and its role in supporting the productive flexibility of the organization.

3.3.2. Dependent variable: Production flexibility:

Table (3): Mean and Standard Deviation of Dependent Variables (Production Flexibility)

Dimension	Mean	Standard Deviation
Machine flexibility	4.18	0.49
New Product Introduction Flexibility	3.97	0.67
Human Resources Flexibility	3.85	0.77
Overall Variable	4.00	–

Table (3) illustrates that all dimensions of production flexibility were rated high by respondents, with an overall mean score of 4.00 on a five-point Likert scale. This denotes that respondents perceive some good level of production flexibility in the company. Machine flexibility had the highest mean score (4.18) and relatively low standard deviation (0.49), which shows the consistency of respondents' opinions about the machine flexibility to adapt to changes in production requirements and reflects their satisfaction with the readiness of the production system.

The average rating for flexibility in introducing new products is 3.97 with a standard deviation of 0.67, showing that this capability is rated relatively high. There is some difference in answers from participants which may be due to different levels of awareness about research and development processes or involvement in new product introductions. Although human resource flexibility had the lowest average rating at 3.85 and the highest standard deviation at 0.77, it still indicates larger variations when assessing employees' capabilities to perform various tasks and adapt to changes in operations. This emphasizes the need for more effective human skill training and development programs to enhance operational flexibility within the firm.

3.4. Indicators reliability:

For the confirmation of the measurement model's reliability, it is required that each indicator should have a factor loading value greater than 0.60. This means that there exists a significant relationship between an observed variable and its corresponding latent construct. Loadings within the range of 0.20 to 0.60 are considered as potential candidates for removal but only if they enhance the general reliability and validity of the Leguina model (2015) [23].

After the first evaluation, the measurement model, including the study's hidden constructs, indicators, and factor loadings, was examined using SmartPLS software. The first results indicated that some indicators did not meet the recommended minimum factor loading (0.60), which could compromise the adequacy of the measurement model.

According to the methodological guidelines of [24], these low-loaded indicators were removed to enhance the reliability of the measurement model and its convergent validity. Following modifications, the measurement model was adjusted to reflect acceptable indicator reliability, as shown in Figure (1).

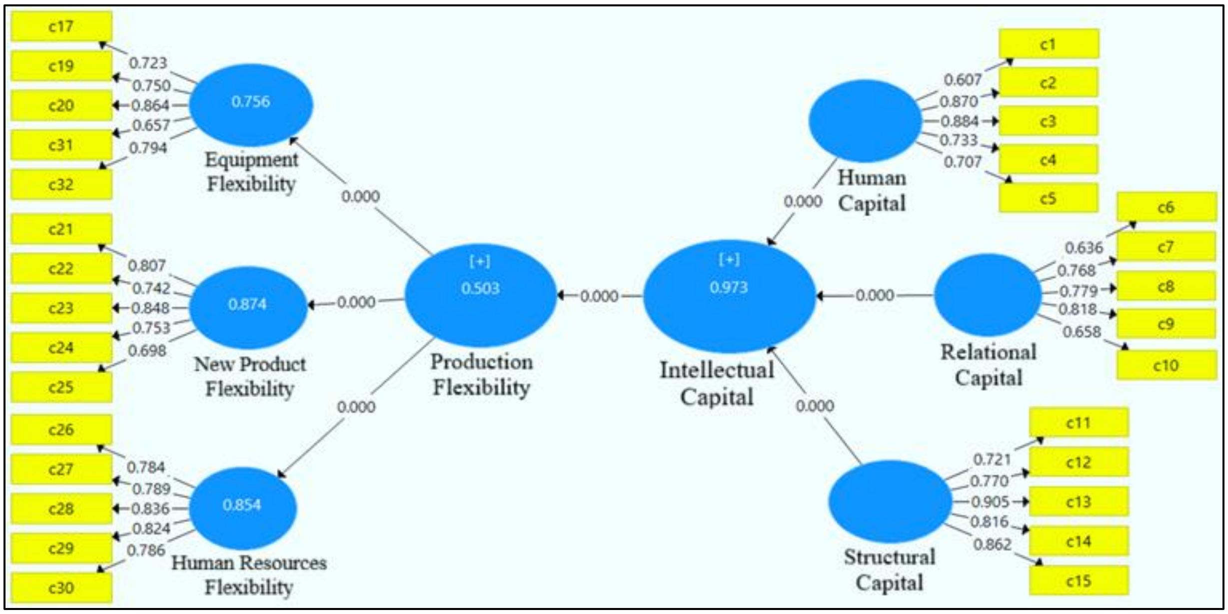

Figure (1). Measurement model showing factor loadings for intellectual capital and production flexibility constructs.

Table (4): Correlation and Differential Validity (Fornell-Larcker)

Variable	Human Capital	Relational Capital	Structural Capital	Hardware Flexibility	New Product Delivery Flexibility	Human Resource Flexibility
Human Capital	0.766					
Relational Capital	0.404	0.846				
Structural Capital	0.523	0.535	0.773			
Hardware Flexibility	0.440	0.501	0.610	0.807		
New Product Delivery Flexibility	0.443	0.729	0.602	0.560	0.853	
Human Resource Flexibility	0.285	0.398	0.421	0.398	0.302	0.832

The results in Table (4) of the Fornell-Larcker criterion indicate the discriminant validity of the study variables. The root mean variance (AVE) values for each variable were higher than the correlation coefficients with the other variables, demonstrating that each variable is sufficiently distinct from the others in the model. The AVE value for human capital was 0.766, higher than all its correlation coefficients with the other variables. Also, the AVE values for relational capital were 0.846 and for structural capital 0.773, which means that they are both bigger than the intervariate correlation coefficients. The dimensions of production flexibility had high AVE values: equipment flexibility (0.807), new product flexibility (0.853), and human resource flexibility (0.832). These values are all greater than their correlation coefficients with other variables. Therefore, it may be inferred that the measurement model has a high level of discriminant validity; this validates the capability of each variable to measure its own dimension without interference from any other variables in this study.

Table (5): Predictive Relevance of the Dependent Variable

Variable	Predictive Relevance Value (Q^2)	Predictive Relevance
Intellectual Capital → Production Flexibility	0.429	Predictive relevance exists ($Q^2 > 0$)

The results presented in Table (5) indicate that the predictive relevance value (Q^2) for the relationship between intellectual capital and production flexibility reached 0.429. Since this value is greater than zero, it indicates that the study model has a good predictive power for the dependent variable, which is production flexibility. The Stone- Geisser (Q^2) criterion states that if values are greater than zero, then predictive relevance exists in the model. This implies that an independent variable such as intellectual capital significantly helps in predicting production flexibility at Dubai Pharmaceutical Industries Company. Thus, findings would confirm that the proposed model has an acceptable level of predictive quality and can be used to explain relationships among the study variables.

Table (6): Effect Size (F^2) :Dependent Variable: Production Flexibility

Relationship	Effect Size (F^2)	Result
Intellectual Capital → Production Flexibility	0.728	Large Effect

The results in Table (6) show that the effect size (F^2) of the relationship between intellectual capital and production flexibility is 0.728, which is considered large according to Cohen's criteria for effect size interpretation since it is greater than 0.35. This finding indicates that intellectual capital has a significant contribution to explaining changes in production flexibility at Dubai Pharmaceutical Industries Company and underscores the fundamental role of intellectual capital and its dimensions in improving the company's capacity to attain higher levels of production flexibility. Furthermore, the results indicate that incorporating the intellectual capital variable into the model had a strong impact on improving the model's explanatory power with respect to the dependent variable.

3.5. Hypothesis Testing:

This section presents the hypotheses concerning Path Analysis, including multipath testing such as direct and aggregate effects, to verify hypotheses, arrive at conclusions, and interpret relationships [24].

H_01: Intellectual capital (human capital, relational capital, structural capital) has no statistically significant effect on production flexibility and its dimensions (hardware flexibility, new product flexibility, and human resource flexibility) at Dubai Pharmaceutical Industries.

The main null hypothesis was tested using Critical Path Analysis. It examined the effect of the independent variable intellectual capital on the dependent variable productive flexibility. Critical Path Analysis is usually applied in project management, however, it seems to have been modified here to explore the connection between intellectual capital and flexibility in production.

Table (7): Effect Coefficients (Intellectual Capital on Production Flexibility)

Path	B Coefficient	Mean	t-value	Statistical Significance	Result
Intellectual Capital → Production Flexibility	0.709	0.709	25.200	**0.000**	Reject null hypothesis; accept alternative hypothesis

Table (7) presents the outcomes related to the assessment of the main null hypothesis (H_{01}) carried out through critical path analysis, wherein the influence of the independent variable intellectual capital on the dependent variable production flexibility was examined. the value of coefficient B was 0.709. This implies a strong positive relationship between intellectual capital and production flexibility. In other words, an increase in intellectual capital will enhance a firm's ability to respond to changes in its operations as well as the innovation of new products and proper management of human resources. The t-coefficient was 25.200 at a significance level of 0.000; therefore, this relationship is statistically significant at any conventional level of confidence.

The results led to the rejection of the null hypothesis ($H_0$1) and the acceptance of the alternative hypothesis. This implies that intellectual capital has a positive and statistically significant impact on production flexibility at Dubai Pharmaceutical Industries. The outcome emphasizes a major investment in all three dimensions of intellectual capital—human, structural, and relational—as a strategy to build resilience in systems, accelerate the time to market for new products, and enhance the performance of human resources, which in turn improves efficiency and effectiveness within company production processes.

3.5.1. Testing Sub-Hypotheses:

$H_0$1-1: Components of intellectual capital do not significantly affect the flexibility of equipment at Dubai Pharmaceutical Industries.

$H_0$1-2: Components of intellectual capital do not significantly affect the flexibility for introducing new products at Dubai Pharmaceutical Industries.

$H_0$1-3: Components of intellectual capital do not significantly impact the flexibility regarding human resources at Dubai Pharmaceutical Industries.

The researchers applied path analysis to test the sub-hypotheses related to the effects of intellectual capital on each dimension of production flexibility.

Table (8): Effect Coefficients (Intellectual Capital on Dimensions of Production Flexibility)

Path	B Coefficient	Mean	t-value	Statistical Significance	Result
Intellectual Capital → Machine Flexibility	0.617	0.617	20.301	**0.000**	Reject null hypothesis; accept alternative hypothesis
Intellectual Capital → New Product Introduction Flexibility	0.663	0.663	23.972	**0.000**	Reject null hypothesis; accept alternative hypothesis
Intellectual Capital → Human Resource Flexibility	0.655	0.655	23.078	**0.000**	Reject null hypothesis; accept alternative hypothesis

The results in Table (8) indicate that intellectual capital has a statistically significant positive impact on the resilience of equipment at Dubai Pharmaceutical Industries, with an impact factor of B = 0.617, a t-value of 20.301, and a significance level of 0.000. This reflects the fact that increasing intellectual capital, through employee skills development, strengthening the organizational structure, and enhancing relationships with suppliers and partners, directly impacts the ability of equipment to adapt to production changes, thereby improving operational efficiency and reducing downtime and maintenance.

Regarding the effect of intellectual capital on the resilience of new product introduction, it was found that the impact factor B = 0.663 with a t-value of 23.972 and a significance level at 0.000. These values indicate that there is a strong and statistically significant positive relationship between intellectual capital and the resilience of new product introduction. This means that investment in intellectual capital increases the ability to quickly develop new products effectively based on organizational knowledge, accumulated experience, and innovation based on strategic relationships with partners and customers to support competitive advantage in the marketplace for the organization.

The coefficient for human resource flexibility was 0.655 with a t-value of 23.078 at the 0.000 level of significance. This indicates that intellectual capital positively influences employees' ability to perform multiple tasks and adapt to changes in operations. It shows that investment in developing human capital, enhancing organizational management, and establishing supportive relationships between employees and management can provide greater flexibility in applying human resources which leads to an overall improvement in the operational flexibility of the company.

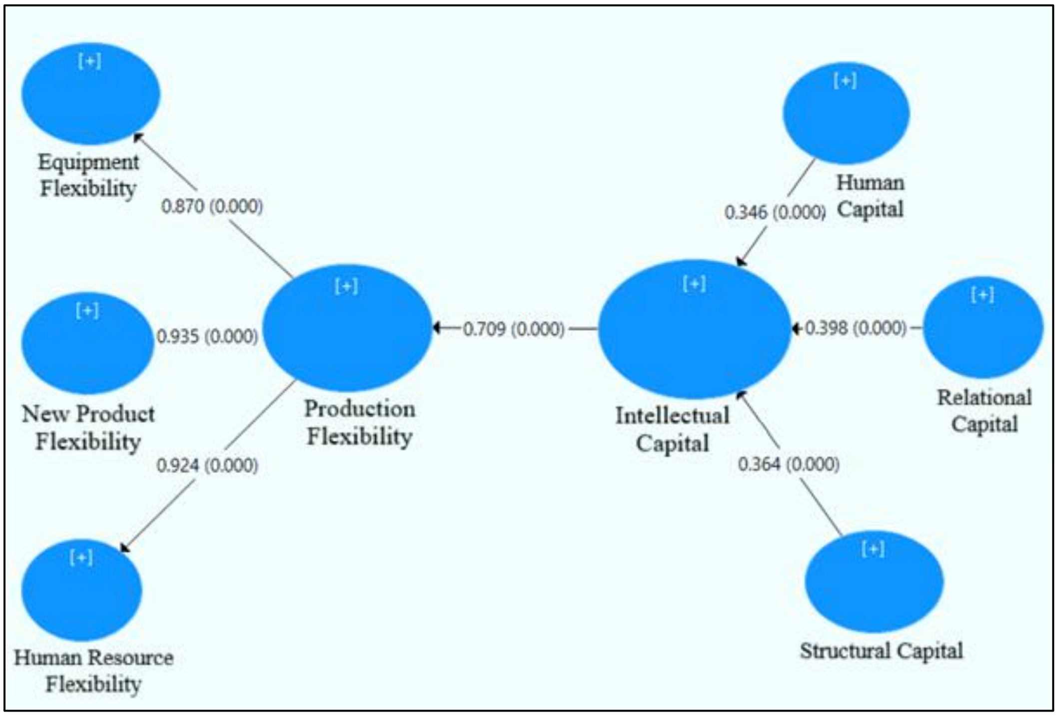

Figure (2). Structural model showing the path coefficients between intellectual capital and production flexibility dimensions.

4. Result & Discussion

1. The study results showed that the components of intellectual capital, such as human capital, relational capital, and structural capital, have a significant effect on the operational flexibility of Dubai Pharmaceutical Industries (DPI) at a significance level of $\alpha = 0.05$.

   This result is consistent with the findings of [1], who found that intellectual capital significantly improves organizational and innovative capabilities to reach growth in small and medium enterprises. Furthermore, this result is in accordance with the findings of [20], which proved that intellectual capital facilitates sustainable competitive performance for enterprises through corporate innovation. These results imply that investments in intellectual capital provide an essential knowledge base and strategic foundation to support operational flexibility in industrial companies.

2. The results indicated that intellectual capital (human capital, relational capital, and structural capital) significantly influences operational flexibility at a significance level of $\alpha \leq 0.05$ for DPI.

   This aligns with the study results like [2] and [19] which associated intellectual capital with adaptability and organizational agility by enhancing human skill development, fortifying organizational structure, and establishing strategic relationships that improve operational performance, speed up the introduction of new products in the market, and increase flexibility in managing human resources. These findings also support what [15] stated about the need to enable exploratory and exploitative intellectual capital to improve organizational performance in dynamic business environments.

3. The study results revealed that intellectual capital (human capital, relational capital, and structural capital) has an impact on the flexibility of introducing new products at Dubai Pharmaceutical Industries at the significance level ($\alpha = 0.05$).

   This is consistent with the theoretical findings of [7] regarding knowledge and production agility. It was found in these studies that knowledge systems and organized human capabilities enhance a firm's ability to cope with changes in its operations by cutting down response time to new developments, thus improving efficiency in machines, products, and even human resources. On another front, though these results further emphasize the need for strengthening relational capital, this has been supported by studies conducted by [5] and [10]. Strong collaborative relationships with partners and suppliers increase operational flexibility while reducing risks related to both supply chains as well as production development.

4. The results indicated that intellectual capital (human capital, relational capital, and structural capital) has a substantial effect on the flexibility of human resources at Dubai Pharmaceutical Industries (DPI) at a significance level of ($\alpha = 0.05$).

   This finding corresponds to studies regarding the complementary role of intellectual capital in enhancing production flexibility, as well as recent literature that links intellectual capital with organizational innovation and competitiveness in both industrial and service business environments, whether small and medium-sized enterprises or large corporations. It stresses the importance of strategically investing in knowledge, skills, and relationships within organizations to help companies achieve sustainable performance that is resilient [3]; [4].

5. Conclusion

This paper presents an empirical study related to intellectual capital and production flexibility at Dubai Pharmaceutical Industries, Samarra, Iraq. The dimensions through which intellectual capital was represented are human capital, relational capital, and structural capital. On the other hand, production flexibility was measured in machine flexibility, new product introduction flexibility, and human resource flexibility. The methodology is descriptive-analytical. Questionnaires were the instrument for gathering data. They were distributed to employees in the company. A total population of 101 employees was considered. Seventy-nine valid questionnaires were returned and used for statistical analysis. The response rate obtained was 78.2%. This response rate is acceptable to provide an empirical test of the relationships proposed between intellectual capital and production flexibility.

The results on reliability confirmed the appropriateness of the measurement instrument for carrying out statistical analyses. The values of Cronbach's Alpha were above the threshold of 0.70 accepted for all main variables and dimensions: human capital at 0.803, relational capital at 0.856, structural capital at 0.842, machine flexibility at 0.761, new product introduction flexibility at 0.839, and human resource flexibility at 0.801. These values indicate a good level of internal consistency and thus support the reliability of the questionnaire items in measuring the study variables.

Results of the description showed that intellectual capital was available at a high level within the organization, with an overall mean of 4.01 on a five-point Likert scale. Among its dimensions, structural capital recorded the highest mean value at 4.35, followed by relational capital at 3.86 and human capital at 3.83. This means that the company has relatively strong internal systems, procedures, and organizational structures while there is still room for further development in employee skills and management of external relationships.

Results further indicated that perceived high levels of production flexibility were achieved with an overall mean of 4.00. The highest mean value was recorded for machine flexibility at 4.18, followed by new product introduction flexibility at 3.97, and human resource flexibility at 3.85. From these, it can be said that the company has fairly good adaptability of its equipment and production processes to changing operational requirements; further improvement is indicated in employee multi-skilling, task redistribution, and flexible human resource practices.

The results of the structural model show that intellectual capital has a positive and statistically significant effect on production flexibility. The main path coefficient was $\beta = 0.709$, with a t-value of 25.200 and a significance level of $p < 0.001$. This means that strengthening intellectual capital will contribute directly to the company's ability to change in production as well as new product introductions and flexible human resource management. The value of predictive relevance $Q^2 = 0.429$ further indicates that the model has good predictive power, while effect size $F^2 = 0.728$ confirms that intellectual capital has a large effect on production flexibility.

Results of the sub-hypotheses also prove that intellectual capital impacts all dimensions of production flexibility significantly. Its impact on machine flexibility was $\beta = 0.617$, $t = 20.301$, and $p < 0.001$. The impact on new product introduction flexibility was even stronger: $\beta = 0.663$, $t = 23.972$, $p < 0.001$. Human resource flexibility also showed a significant impact: $\beta = 0.655$, $t = 23.078$, $p < 0.001$. These results show that intellectual capital contributes most strongly to support new product introduction flexibility followed by human resource flexibility and then machine flexibility.

This result has shown that knowledge-based resources are not only intangible organizational assets but also actual promoters of operational flexibility. Human capital will enhance skills, experience, learning capacity, and the ability to perform multiple tasks. Structural capital will provide direct support for flexibility — systems, procedures, databases, and organizational routines. Relational capital promotes flexibility by enhancing cooperation with suppliers, customers, partners, and other stakeholders. These dimensions together help the company reduce response time, improve production efficiency, support product development, and enhance its capacity to respond to market and operational changes.

Theoretically, this study builds a bridge for the connection of intellectual capital to production flexibility in an applied pharmaceutical industry within the literature. Most prior research has considered the influence of intellectual capital on financial performance, innovation, or competitive advantage. In this study, therefore, that discussion is expanded to how intellectual capital can be turned into operational flexibility. Hence, the results provide evidence that intellectual capital is a strategic resource that makes the organization more flexible and, therefore, able to compete sustainably.

This study has very useful implications for managers in pharmaceutical and industrial organizations. Thus, it is recommended that companies aiming at enhancing production flexibility do not only depend on physical assets, machinery, or technology. Such companies should also invest in employee training and knowledge sharing, flexibility at the organizational level, innovation-supporting procedures, and strategic relationships with suppliers and customers. These will enhance the organization's capability to respond to changes in demand as well as mitigate operational risks while introducing new products more effectively with long-term competitive performance.

Intellectual capital is, therefore, a core determinant of production flexibility at Dubai Pharmaceutical Industries. The study proves that firms which can manage and develop their human, structural, and relational capital are better suited to respond to changes in production, improve machine flexibility, hasten the introduction of new products, and use human resources optimally. The model proposed in this study can be extended by testing it in other pharmaceutical companies or industrial sectors, considering the mediating role of organizational innovation, digital transformation, knowledge management, or supply chain flexibility between intellectual capital and production flexibility.

5.1 Recommendations:

1. Continuous training and professional development programs should be put in place by organizations to improve the skills and competencies of their employees, which will also help facilitate knowledge sharing among employees and thus, the organization's human capital will be strengthened.
2. Companies should have flexible administrative and technological systems, where integrated information systems support production activities and enhance the organization's flexibility in responding to changes in operations and markets.
3. Firms should further develop their strategic partnerships with key stakeholders, suppliers, customers, and research institutions because such collaborations will enhance the exchange of knowledge, support innovation, and thus improve overall effectiveness in organizational operations.

4. Organizations should focus on developing human capabilities at the same time as improving organizational structures. A periodic review of the components of intellectual capital will help organizations identify strengths and areas that need further improvement.
5. An innovative organizational environment is equally important in this by encouraging and rewarding new ideas, fostering cooperation among departments, and improving communication between them.
6. Subsequent research could investigate the association between intellectual capital and production flexibility in other pharmaceutical or industrial organizations. Future studies could also explore the role of additional factors, such as organizational innovation, organizational culture, and digital technologies, in shaping this relationship.

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