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# قياس أثر رأس المال الفكري على الإنتاجية وقرارات الاستثمار: دراسة تطبيقية على الشركات المقيدة بسوق الآوراق المالية المصري

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# Measuring the impact of intellectual capital on productivity and investment decisions: An empirical study on non-financial listed companies on the Egyptian Stock Market

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**Abstract:**

This research aims to examine the impact of intellectual capital (IC) on productivity and investment decisions using sample consists of 117 non-financial listed Egyptian companies with total of 553 observations for the period from 2012 to 2019. The independent variable is the intellectual capital, which is measured by the value added intellectual capital model (VAIC) that consists of its three components; human capital efficiency (HCE), Structural capital efficiency (SCE) and capital employed efficiency (CEE). The value added is measured by total income minus all expenses (except labor, taxation, interest, dividends, depreciation)**.** The intellectual capital is measured by the summation of the three components and by each component separately. The HCE is measured by value added over salaries and wages expenses. The SCE is measured by the difference between value added and salaries expenses over value added. Finally, the CEE is calculated by value added over net assets. The research has two dependent variables;

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the first dependent variable is the productivity which has three indicators; employee productivity (EP) measured by revenue per employee, employee productivity measured by earning per employee, and asset productivity measured by asset turnover. The second dependent variable is the investment decisions, which are measured by fixed assets over total assets. The results showed that there is a significant positive relationship between IC and the two proxies of the employee productivity, and there is a significant negative relationship between IC and investment decisions. There is insignificant relation obtained with asset productivity. More specifically for the components of the intellectual capital, HCE and SCE have a significant positive impact on employee productivity and significant negative impact for SCE on investment decision. Insignificant association is found between the intellectual capital and its components and asset productivity. In addition there is no impact for CEE on all the dependent variables.

**Key words**: Intellectuals capital, value added, human capital efficiency, Structural capital efficiency, capital employed efficiency, employee productivity, asset productivity, and investments decisions.

**ملخص البحث**

يهدف هذا البحث إلى قياس أثر رأس المال الفكري على كل من الإنتاجية وقرار الاستثمار باستخدام عينة مكونة من ١١٧ شركة غير مالية مقيدة بسوق الأوراق المالية المصري في الفترة من ٢٠١٢ إلى ٢٠١٩ باجمالي عدد مشاهدات ٥٥٣ مشاهدة. ويتمثل المتغير المستقل في رأس المال الفكري والذي تم قياسه اعتماداً على نموذج القيمة المضافة لرأس المال الفكري، والذي يضم ثلاثة مكونات هي كفاءة رأس المال البشري، وكفاءة رأس المال الهيكلي، وكفاءة توظيف رأس المال. وقد تم قياس القيمة المضافة من خلال الفرق بين الايردات وكافة المصروفات فيما عدا (المرتبات، والضرائب، والفوائد، والتوزيعات، والاهلاك). كما تم قياس رأس المال الفكري من خلال مجموع مكوناته الثلاثة. في حين تم قياس كفاءة رأس المال البشري من خلال خارج قسمة القيمة المضافة على مصروف الأجور والمرتبات. وبالنسبة لكفاءة راس المال الهيكلي، فقد تم قياسه بالفرق بين القيمة المضافة ومصروف الأجور والمرتبات مقسوماً على القيمة المضافة. وأخيراً فيما يتعلق بكفاءة توظيف رأس المال، فقد تم قياسه من خلال قسمة القيمة المضافة على صافي الأصول. ويركز هذا البحث على متغيرين تابعين هما؛ الإنتاجية وقرارات الاستثمار. وفيما يتعلق بالمتغير التابع الأول الخاص بالانتاجية فقد تم قياسه من خلال ثلاثة مؤشرات هي؛ معدل الإيرادات إلى عدد العاملين، ومعدل الأرباح إلى عدد العاملين، ونسبة الايردات إلى إجمالي الأصول. وبالنسبة للمتغير

التابع الثاني الخاص بقرار الاستثمار فقد تم قياسه بنسبة الأصول الثابتة إلى إجمالي الأصول. وقد أشارت النتائج إلى وجود تأثير معنوي إيجابي لرأس المال الفكري الكلي على إنتاجية العامل بمؤشريه، مع وجود تأثير معنوي سلبي له على قرارات الاستثمار، وعدم وجود علاقة معنوية بينه وبين إنتاجية الأصول. وبصورة أكثر تحديداً لمكونات رأس المال الفكري، فقد أكدت النتائج على وجود علاقة معنوية طردية لكل من كفاءة رأس المال البشري وكفاءة رأس المال الهيكلي على مؤشري إنتاجية العامل، مع ووجود علاقة معنوية عكسية بين كفاءة رأس المال الهيكلي وقرار الاستثمار. كذلك بينت النتائج عدم وجود علاقة معنوية لرأس المال الفكري بمكوناته الثلاثة على إنتاجية الأصول، بالإضافة إلى عدم وجود أي تأثير معنوي لكفاءة توظيف رأس المال على أي من المتغيرات التابعة.

**الكلمات المفتاحية:** رأس المال الفكري، والقيمة المضافة، وكفاءة رأس المال البشري، وكفاءة رأس المال الهيكلي، وكفاءة توظيف رأس المال، وانتاجية العامل، وانتاجية الأصول، وقرارات الاستثمار.

## 1. Introduction:

The world nowadays is moving from the fourth industrial revolution compromising robotics and artificial intelligence into the fifth industrial revolution which links between human and machine and enables innovation and creative people to connect. Innovation increases productivity and growth through creating new value (Li et al., 2021). The time for the fifth industrial revolution has started, and the overall world business environment is rapidly changing, and accounting is required to be adapted and to change consequently; it is time to move from "knowledge is power" (Rechberg and Syed, 2013) into intellectual capital (IC) –hereafter IC- which includes man experience and knowledge (Saunders and Brynjolfsson, 2016). Today's companies have changed their strategy from capital-driven to knowledge- driven (Nadeem et al., 2019; Xu et al., 2022) and from the industrial economy to the knowledge economy (Forte et al., 2019). Somehow, some countries are still in the third industrial revolution era; Egypt is moving today to the fourth revolution in steady steps following its 2030 vision.

Recently the competitive advantage has been driven by the intangibles rather than tangible intensive assets in the modern knowledge-based economy (Farooq et al. (2022). The intangibles enhance the efficiency of investment in intangibles such as machinery and plants. Duho (2022) defined IC or intangibles as the resources held by the company that are nonmonetary or lack physical nature including

licenses, patents, software, customer lists, contracts, and goodwill. Xu et al. (2022) clarified that when the organizational structure is well established, then the companies start to pay more attention to technological innovation through both HC and SC and gradually through rational capital (RC).

The COVID 19 pandemic had a negative effect overall the world; its impact on firms during the lockdown period is always under study. Duho (2022) stated that many firms had stop purchasing fixed assets and started to heavily depend on its information technology and other intangible assets. Thus, recently the efficient exploitation of information and information technology is important for facing both competition (Chowdhury et al., 2019; Duho, 2022) and failure risk. The intangible investment is a fundamental requirement for companies that wish to move to the fourth industrial revolution and to success in it especially after the pandemic. Additionally, Bchini (2015) declared that intangible projects need good strategic management due to their high failure frequency. These investments are characterized by their lack of materiality, and the high insolvency risk due to its absence of collateral secured on the property. On the other hand, Farooq et al. (2022) advocate that the financial and non-financial factors for IC reduce systematic risks and contribute for long-term investments. The IC as well maximizes investment (Farooq et al. 2022; Kasoga, 2020) and

production cost efficiency and increases capital investments (Farooq et al., 2022)

Li et al. (2021) demonstrated the link between IC and innovation for the financial flourishment; whereasthey considered IC as an important ingredient for setting strategy and for any organization future flourishment. The fourth industrial revolution becomes the catalyst for recent technology innovation, sustainability and inclusive growth and its foundation for connecting between innovation and IC in financial and knowledge economic flourishment. The IC is a key determinant for the employee productivity (EP) and a branch for firm performance. Buallay et al. (2021) indicated the organizations' movement to using the IC and EP as a performance measure rather than traditional performance measurements such as profitability, sales volume and market share.

**The research problem** discusses the man power constituting the fifth industrial revolution through the IC three different components (HCE, SCE, and CEE) and their impacts on productivity and investment decisions. It is important to understand the Egyptian minds during the recent worldwide changes and where Egyptian companies stand today to face the rapid technological changes and the attack of AI technology on the accounting profession and the replacement of man in most industries. This research enhances the importance of human power in understanding the IC and its disclosure where today

the measurement and disclosure of IC does not reflect its actual value. The investment decisions especially what is related to the innovations, research and development and technology are questionable in Egypt; it is crucial to enhance the different industries to increase this type of expenses and strengthen the Egyptian leadership in different businesses across borders.

The research problem can be expressed in the following questions:

- What is the effect of intellectual capital on employee productivity and asset productivity in non- financial companies listed on the Egyptian stock market?
- Is there any relationship between the intellectual capital and investment decisions? And what is the direction of this relationship?
- What is the impact of human capital efficiency on productivity and investment decisions on the Egyptian stock market?
- Is there any association between structural capital efficiency and both the productivity and investment decisions?
- Does capital employed efficiency have any impact on productivity and on investment decisions in listed companies on the Egyptian stock market?

**This research sheds the light on** the IC, and its impact on EP, and investment decisions in the Egyptian companies listed on Egyptian stock market to broaden both the IC and the value added concepts. IC is measured by the value-added intellectual coefficient (VAIC) model through using three coefficients; human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE).

**The research aims** to deeply investigate the link between the IC through VAIC and productivity including the man or human productivity through the EP proxy and the productivity of assets. Then the research studies the impact of VAIC on the investment decisions to understand the relationship between them. Hence, **the research objectives are:**

***$O_1$: to investigate the impact of the three components of IC on employee productivity measured by revenue per employee.***

***$O_2$: to determine the impact of the three components of IC on employee productivity measured by earning per employee.***

***$O_3$: to understand the impact of the three components of IC on asset productivity.***

***$O_4$: to examine the impact of the three components of IC on investment decisions.***

**The research importance** stems from the fourth industrial revolution great impact on today accounting methods and standards. Time to change has come, whereas the technology and innovative techniques including artificial intelligence have forced the world to adapt the IC and depend more on the man knowledge and experience. Most countries have reached the fourth industrial revolution which is based on machine learning, and few are reaching the fifth industry revolution which is based on man power.

The remainder of this paper is organized as follows: section 3 presents the theoretical background. Section 4 illustrates literature review and hypotheses development. Section 5 discusses the research design. Section 6 presents the empirical results and discussion. Section 6 extends the additional analyses. Section 7 addresses the conclusion.

## 2. Theoretical background:

Recently IC has attracted many researchers to focus their research on it to enhance the knowledge and competitive advantage contribution to the literature. The IC is essential in understanding the knowledge-based economy (Chowdhury et al., 2019). IC concept was first introduced in a magazine article by Tom Stewart in 1991(Kalkan et al., 2014).

One of the value adding methods for the IC is the use of VAIC; the Modified Value-Added (MVAIC) method combine the four aspects

of the IC together to maximize the IC value. IC incorporates human resources in HC and non-human resources in SC such as database, strategies, methods, and techniques. IC includes capital productivity in CEE and business-stakeholder relationship in RC (Li et al.2021).

Ismail (2020) questioned the accuracy of accounting and measurement methods used in calculating the physical assets. He declared that financial assets in financial statements represent only 20% of its actual value in the company's balance sheet. Therefore, he doubted the credibility of the financial statements and prompted the use of IC to enhance the firm value especially in Egypt due to its steady movement toward knowledge economy. Ismail declared that although investment in IC in many countries represents at least 10% of GDP, however, in Egypt it represents only 1% of GDP.

IC is present in all industrial sectors and recently most companies are shifting from traditional to modernized technology for the value creation and competitive issues (Shih et al., 2010; Maditinos et al., 2011). Recently Forbes provides the ranking of the world's most innovative companies on a yearly basis (Li et al., 2021). Kasoga (2020) defined intellectual capital as client relationship, ownership of knowledge, organization innovation, applied experience, and professional skills which make esteem and give value creation to the organization.

Duho (2022) distinguished between the intangible and tangible assets; intangibles are not physical assets and are known as intellectual or intangible capital and they are value-creating assets, while tangibles are physical assets including current and physical assets. Intangibles incorporate customer lists, licenses, patents copyrights, franchises, and goodwill. Duho indicated that accounting standards focused on tangible assets and ignored intangibles; the failure of IAS 38: Intangible Assets and the FASB Summary of Statement No. 142 is proved in many studies such as Duho (2022). Intellectual capital mainly consists of three basic components; HCE, SCE and CEE (Kalkan et al., 2014; Chowdhury et al., 2019). HCE represents the human capital and SCE represents the non-human capital which is concerned with innovations (Forte et al., 2019) and CEE which is related to stakeholders.

On the other hand, Ismail (2020) classified intangible assets according to FASB into customer-related intangibles, contract-related intangibles, marketing-related intangibles, artistic-related intangibles, and technology-related intangibles. Marketing-related intangibles include brand names, internet domain trademarks, brand names, and newspaper mastheads, while customer-related intangibles include contracts, customer lists and production backlog.

Artistic-related intangibles include, audiovisual production, and television programs, literary and musical works, and plays, while contract-related intangibles include franchise agreements and licenses. Finally, technology-related intangibles includes patents and trade secrets.

Intellectual capital is not recorded or represented in the financial statements as accounting assets (Liang and Lin, 2008; Nadeem et al., 2019). From the other challenges that face IC is its difficult accounting measurement compared with physical assets (Chowdhury et al., 2019; Ismail, 2020). IC would affect both micro and macro levels, whereas IC affects the firms' both financial and non-financial performance as well (Li et al., 2021). The investment and economic growth in macro and financial disclosure issues in macro are affected. Another challenge is the value measurement for the IC (Chowdhury et al., 2019).

According to Ismail (2020); there are many methods and techniques that are used to measure intangibles with different results and indicators. The first method is direct intellectual capital through estimating the monetary value whether individually or aggregately. The Second one is the market capitalization method; through calculating the difference between market value and book value of company's total investment. The third is return on asset method which is calculated by scaling average earnings by average cost of capital. The fourth method

is the Scorecard and the fifth one, is the expenditure-based approach. Finally and most used method is the VAIC.

According to Criekingen et al. (2021) there are six approaches used to measure intangibles which are, the survey-based measurement of expenditures approach, occupation or task-based approach, the expenditures-based approach, intellectual property rights-based measures, the measurement based on firm balance sheet data, and market valuation approach. Survey-based measurement focuses on design, intellectual rights, R&D, and training for the purpose of innovations. Occupation or task-based approach is considered a type of expenditure-based approach to quantify the intangible investments based on their generating resources. Expenditures-based approach represents the macroeconomic framework including economic competencies, innovative property and computerized information. The balance sheet data-based approach uses intangibles as represented in the financial statements with focusing on intangible fixed assets, R&D expenditures, or a portion of selling, general and administrative expenditures.

There are huge number of theories that recognize the intellectual capital resources such as the stakeholder theory which demonstrates the impact of innovation on value creation and sustainability (Chowdhury et al., 2019), and future growth (Burgman and Roos, 2004). Another crucial theory is the resource-based theory, which categorized assets

into tangible and intangible assets and support the impact of intellectual capital on productivity and value creation (Kesse, & Pattanayak, 2019). The knowledge of the company is an extension of its resources (Hoskisson et al., 1999), this theory matches the VAIC model that extends the IC efficiency and knowledge based development to achieve value creation and reach sustainability.

## 3. Literature Review and hypotheses development

There are many studies that investigated the intellectual capital dimensions (Arenas & Lavaderos, 2008; Bchini, 2015), measurements(Chen, Zhu & Yuanxie, 2004) its role in value creation(Hermans & Kauranen, 2005; Tseng & James Goo, 2005;La Rocca, La Rocca, & Cariola, 2008; Diez et al., 2010; Ferchichi & Paturel, 2013), and its impact on performance( Vătămănescu et al., 2019; Xu & Wang, 2019). On the other hand, less studies examined its role in investment decisions (Farooq et al., 2022), innovation, and productivity. The studies of IC in emerging markets and in different economic conditions are few (Kasoga, 2020). Accordingly, the literature that discusses the relation between IC and both asset productivity and EP and investment are quiet limited and there is no studies (to the knowledge of the researchers) found in the Egyptian economy.

### 4-1- The relationship between intellectual capital and employee productivity

The need for more IC research dimensions would expand understanding for investment, productivity, and performance of firms and improve their intellectual resources exploitation (Kasoga, 2020). In addition, Oppong and Pattanayak (2019) supported the role of IC in increasing productivity and competitive advantages.

From the early studies that pioneered this area is Lönnqvist (2007) who studied the relationship between IC and productivity in 20,000 Finnish companies from 2001 to 2003. Lönnqvist could not prove the relationship empirically. Another study was applied by Costa (2012) who ranked the best practices of IC of Italian yachting companies efficiency and productivity in the 4 years period 2005–2008 through the use of Data Envelopment Analysis (DEA) and Malmquist Productivity Index (MPI).

Following the same line of literature; Hakkak et al. (2016) examined the impact of IC on human resource productivity through using the employee knowledge as a mediating factor. The study used a survey distributed on 120 persons from the department of transportation staff in Tehran. Their results showed that knowledge management mediates the effects of IC on human resource productivity.

On the other hand, Chowdhury et al. (2018) investigated impact of IC on productivity in Bangladeshi Textile Sector and they found that VAIC positively improves productivity, and that SC has significantly affected EP but HC has not any impact on EP.

Buallay et al. (2021) studied the relationship between IC which is measured by VAIC through HCE, SCE, and CEE with EP from 2012 to 2014 in the Gulf Cooperation Council (GCC) region in 198 firms listed in Saudi Arabia and Bahrain. They found that HCE is the most value generator for the IC investment, while the CEE is the lowest. They found that there is a positive relationship between VAIC and the EP. The study recommended the GCC leaders to invest more in HCE. While the study of Hersugondo and Handriani (2021) which investigated the effect of IC on productivity of 30 Indonesian banks from 2016 to 2018, found that VAIC in CEE has a positive impact on productivity while both SCE and HCE have no effect.

Hintzmann et al., (2021) examined the relationship between IC and labor productivity growth in 18 European countries from 1995 and 2017. They found that the three components of IC contribute to the labor productivity growth. They found that the intangibles that are related to economic and innovation have higher impact such as research and development, design, advertising and marketing, and capital.

Idiaro and Abubakar. (2022) investigated the impact of HCE on the EP in 75 Nigerian companies, and their results recommended the authorities to strengthen the role of HCE and the employee relationship with the company strategies and policies.

Nejjari and Aamoum (2022) investigated the relationship between IC and productivity for 82 observations in Casablanca Stock Exchange from 2010 to 2020. They found that HCE had the greatest effects on productivity followed by CEE. They found as well that firms had a higher HCE than SCE.

According to the previously mentioned literature, the following hypotheses can be derived:

***$H_1$: There is a significant positive relationship between IC and revenue per employee***

**$H_{1\text{-}a}$:** There is a significant positive relationship between HCE and revenue per employee.

**$H_{1\text{-}b}$:** There is a significant positive relationship between SCE and revenue per employee.

**$H_{1\text{-}c}$:** There is a significant positive relationship between CEE and revenue per employee.

***$H_2$: There is a significant positive relationship between IC and earning per employee***

**$H_{2\text{-}a}$:** There is a significant positive relationship between HCE and earning per employee.

**$H_{2\text{-}b}$:** There is a significant positive relationship between SCE and earning per employee.

**$H_{2\text{-}c}$:** There is a significant positive relationship between CEE and earning per employee.

### 4-2- The relationship between intellectual capital and asset productivity

It is important in studying the impact of IC on productivity to not forget its effects on FP. Xu et al., (2022) studied the impact of IC on FP through life cycle stages of Chinese manufacturing listed companies during 2014–2018 using the MVAIC model. They found that the impact of IC on FP is different across life cycle stages; at the introduction stage HCE, SCE, and INC are the most active and positively affect the FP. At the growth and maturity stages, all IC components improve FP. At the renewal stage both HC and SC are the key players, while at the decline stage; only HCE has a positive impact on FP.

Through the Fourth Industrial Revolution effects; the value added impacts should not be ignored when studying IC. Li et al. (2021) examined impact of both IC and Value creation on FP for the top 100 innovative companies from different countries and sectors indexed by Forbes 2016 for the period 2011 - 2015. The study revealed that CEE

and HCE had a significant positive impact on FP, while CE and SC efficiency had no relation. They found that RC efficiency is positively related to the value creation of innovative firms, while all other IC components and MVAIC are not related to it. With the same line of literature findings, Ismail (2020) examined the relation between IC and firm value and FP for a sample of listed Egyptian Stock Exchange firms from 2000 through 2014. Results revealed that the level of intellectual capital had a positive impact on firm value measured by Tobin's Q.

Other studies that examined the impact of IC value (VAIC) on the firm value through Tobin's Q are Berzkalne and Zelgalve (2014) who used data for 64 companies over a seven years and Nejati and Pirayesh (2015) who used 132 firms from the Tehran Stock Exchange over six years. Both studies concluded that a positive and significant relationship did exist between intellectual capital and firm value. Both Ferchichi & Paturel (2013) and Bchini (2015) examined the impact of IC disclosure on value creation for 50 and 104 companies listed on the Tunis Stock Exchange respectively. Both of them concluded that information on intellectual capital is positively and significantly correlated with the value creation of the company. On the other side; Iranmahd et al. (2014) concluded that neither intellectual capital nor its components had any significant relation with firm value.

Another study that examined the impact of IC on FP is Duho (2022)'s which used the VAIC model for 59 firms operating from 2007 through 2018 in West Africa. The study found that VAIC, ICE, HCE and SCE measures of intellectual capital are important in improving the performance of firms. Kasoga (2020) as well evaluated the relationship between IC and FP in Tanzania for the period 2010 - 2019. Using the measures SG, ROA, ATO, and Tobin's for FP, Kasoga found a significant positive relationship between SC efficiency and SG, ROA, ATO, and Tobin's and a negative relationship between IC and both HC and capital employed efficiency.

Zhang et al. (2021) studied the IC and its impact on FP in both financial and pharmaceutical industries of total of 149 Vietnamese firms comprising of 108 financial firms and 41 pharmaceutical firms. VAIC is used to measure IC and both ROA and ROE are used in measuring the FP. They found that SCE had adverse impact on ROA and positive impact on ROE. From industry perspective, VAIC had positive impact on ROA and ROE in financial firms but without any effect on pharmaceutical industry firms. HCE had a stronger impact on ROA in financial firms, while HCE and SCE had a stronger impact on ROE pharmaceutical industry, but the effect of HCE on ROE and SCE on ROA is stronger in pharmaceutical firms.

On the other side; Oppong & Pattanayak (2019) studied the IC impact on improving the bank productivity in 73 Indian commercial banks from 2006 to 2017 through examining the impact of IC investment on improving bank productivity measured in terms of asset turnover (ATO) and EP. They found that some components of IC improve productivity.

According to the previously mentioned literature, the following hypotheses can be derived:

***$H_3$: There is a significant positive relationship between IC and Asset productivity***

**$H_{3\text{-}a}$:** There is a significant positive relationship between HCE and asset productivity.

**$H_{3\text{-}b}$:** There is a significant positive relationship between SCE and asset productivity.

**$H_{3\text{-}c}$:** There is a significant positive relationship between CEE and asset productivity.

**4-3- The relationship between intellectual capital and investment decisions**

From the studies that examined the impact of IC on productivity and investment is Ferreira and Martinez (2011) study which examined data from 440 employees at 13 Portuguese companies and found companies with higher SCE scores would have low human resources investments and higher productivity, while companies with higher customer capital investments would have lower productivity. Kelchevskaya et al. (2021) proposed models to examine the effects of IC components on investment t decisions in Russian companies. The results showed a positive relationship between revenue, and market share as indicators for the investment attractiveness and both static and dynamic IC.

Farooq et al. (2022) investigated the impact of both market capitalization and IC on investment decisions through studying non-financial publicly listed corporations in China, India, and Pakistan from 2010 through 2019. They found that there is a positive significant effect of market capitalization (MC) and IC on investment decisions and also of human capital, structural capital, and capital employed efficiency in protecting industrial investment.

According to the previously mentioned literature, the following hypotheses can be derived:

***$H_4$: There is a significant relationship between IC and investment decisions***

**$H_{4\text{-}a}$:** There is a significant relationship between HCE and investment decisions

**$H_{4\text{-}b}$:** There is a significant relationship between SCE and investment decisions

**$H_{4\text{-}c}$:** There is a significant relationship between CEE and investment decisions

## 5- Research Design

### 5-1-Research sample and data collection:

This paper depends on secondary sources in collecting financial and non-financial data. Financial data is collected from the financial statements and annual reports for listed companies available on Egyptian stock market, and non-financial data including the number of employees are extracted from annual report, board of directors' report, and all other relevant information available on the company's web sites. The main population of this paper is the non-financial companies listed on Egyptian stock market for the period before COVID-19 from 2012 to 2019 to avoid the pandemic effect.

The banks and financial institutions are excluded from the beginning due to their special regulations. The companies with missing data regarding the main or control variables are also excluded. In addition, the researchers excluded the companies with abnormal values such as negative equity or negative value added and companies with less than 10 employees. Table (1) summaries the final sample classified according to different industry sectors.

**Table (1)**
**Research sample**

| Industry sector | Number of companies | Total observations |
|---|---|---|
| Communications and utilities | 3 | 17 |
| Constructing and Buildings | 14 | 75 |
| Real estates | 13 | 56 |
| Food and beverage | 24 | 104 |
| Industrial products | 11 | 72 |
| Health care and pharmaceuticals | 15 | 81 |
| Tourism | 12 | 44 |
| Petrol and chemicals | 7 | 25 |
| Home and personal products | 10 | 49 |
| Trade and basic resources | 8 | 30 |
| **Total** | **117** | **553** |

Accordingly, the final sample includes 117 non-financial companies with total 553 observations.

**5-2-Variables measurements**

The main independent variable is the intellectual capital which is decomposed into three components human capital efficiency, structural capital efficiency, and capital employed efficiency. The intellectual capital is calculated by the value added of intellectual capital model (VAIC) that reflects the relation between inputs and outputs.

Two proxies are used to measure the value added. The first one is used in the main analysis whereas value added is calculated by the difference between revenues and all expenses except tax, depreciation, interest, dividends, and salaries. The second proxy is used in the additional analysis and is calculated by net income plus salaries expenses. Table (2) presents the variable measurements.

| Variables | Components | Measurements | Reference |
|---|---|---|---|
| Independent variable | | | |
| Intellectual Capital | Value added | Value added equals total income - all expenses (except labor, taxation, interest, dividends, depreciation) | Zhang et al., 2021 |
| | Human Capital Efficiency HCE | HCE= Value added/ (total salary and wage expenses). | Hegazi et al., 2016 Zhang et al., 2021; Ovechkin et al., 2021; Buallay et al., 2021 |
| | Structural Capital Efficiency SCE | SCE= (value added – salaries expenses)/ value added. | Alipour and Gorgizadeh, 2017) Zhang et al., 2021<br>Buallay et al., 2021 |
| | Capital Employed Efficiency CEE | CEE= value added/ book value of net assets (total assets-total liabilities) | (Ovechkin et al., 2021) Xu and Liu, 2020 |
| | Intellectual capital | = HCE+ SCE+ CEE | 2016 Zhang et al., 2021; Ovechkin et al., 2021 |
| Dependent variables | | | |
| 1- Productivity | | | |
| Employee productivity_1 | Revenue per employee R/E | Total revenues /no .employees | Ahangar, 2011; Kasoga, 2020 |
| Employee productivity_2 | Earning per employee E/E | Pre –income tax/ no .employees | Oppong and Pattanayak, 2019 |
| Asset productivity | Asset turnover | Total revenues over total assets | Oppong and Pattanayak, 2019; Nejjari and Aamoun, 2022 |
| 2- Investment decisions | | | |
| Investment decisions | | Net fixed assets/ total assets | Mirza et al., 2020; Farooq et al., 2022 |
| Control variables | | | |
| Financial leverage | | Total liabilities/ total assets | Xu and Liu, 2020, Ahangar, 2011 |
| Cash flow ratio | | Operating cash flow/ total assets | |
| Firm size | | Log of total assets | Bually et al., 2021; Oppong and Pattanayak, 2019 |
| Liquidity | | Current assets/current liabilities | Hegazi et al., 2016 |
| Age | | Number of operating years for the company | Lee and Lin, 2019 |
| Industry sector | | A dummy variable for each sector | Bually et al., 2021 |
| Year | | A dummy variable for each year | Xu and Liu, 2020 |

Two dependent variables are used in the study, productivity and investment decisions. Three indicators are used to measure productivity. The first dependent variable is the productivity, which has three indicators; employee productivity measured by revenue per employee and employee productivity measured by earning per employee, and asset productivity measured by revenues over total assets. The second dependent variable is the investment decisions, which is measured by fixed assets over total assets. Figure (1) presents the research model.

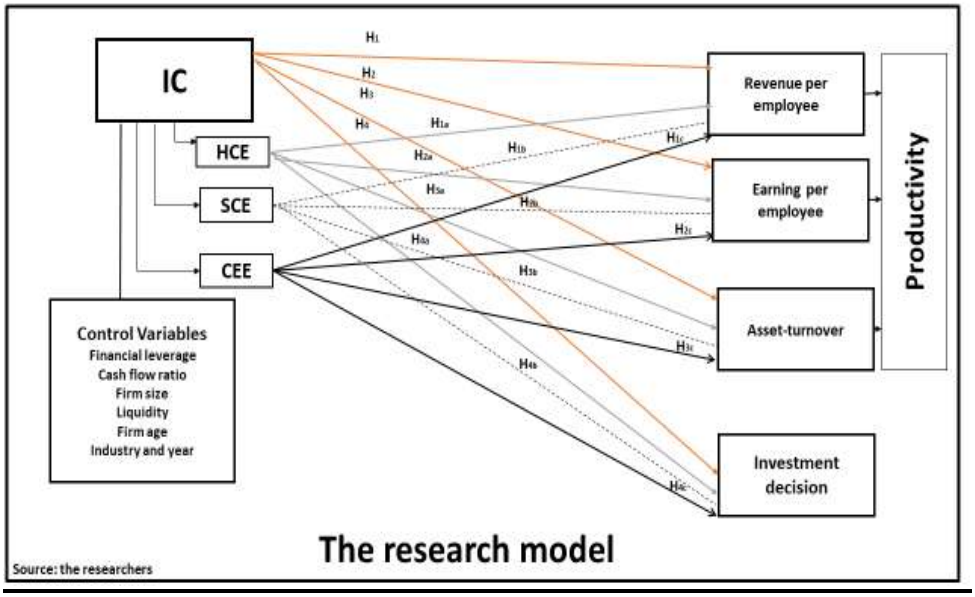


**Figure (1): The research model**

**5-3-Regression models**

The regression models are determined based on testing the impact of IC including the three components. IC is tested in total once and in separated components (Oppong and Pattanayak, 2019). Four groups of regression models are applied and each group consists of two sub models as follows:

**Model (1): The impact of intellectual capital on employee productivity measured by revenue per employee.**

The first regression model is divided into sub models. The first model tests the impact of total intellectual capital on the employee productivity measured by revenue per employee. The second one tests the impact of the three components of intellectual capital separately on revenue per employee. Model (1) is presented as follows:

$$R/E_{it} = \beta_0 + \beta_1 IC_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad \text{(1-1)}$$

$$R/E_{it} = \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 SCE_{it} + \alpha_3 CEE_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad \text{(1-2)}$$

**Model (2): The impact of intellectual capital on employee productivity measured by earning per employee.**

The second regression model is divided into sub models. The first model tests the impact of total intellectual capital on the employee productivity measured by earning per employee. The second tests the

impact of the three components of intellectual capital separately on earning per employee. Model (2) is presented as follows:

$$E/E_{it} = \beta_0 + \beta_1 IC_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad \text{(2-1)}$$

$$E/E_{it} = \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 SCE_{it} + \alpha_3 CEE_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad \text{(2-2)}$$

**Model (3): The impact of intellectual capital on asset productivity**

The third regression model is divided into sub models. The first model tests the impact of total intellectual capital on the asset productivity. The second tests the impact of the three components of intellectual capital separately on asset productivity. Model (3) is presented as follows:

$$Ass/T_{it} = \beta_0 + \beta_1 IC_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad \text{(3-1)}$$

$$Ass/T_{it} = \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 SCE_{it} + \alpha_3 CEE_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad \text{(3-2)}$$

**Model (4): The impact of intellectual capital on investment decisions**

The fourth regression model is divided into sub models. The first model tests the impact of total intellectual capital on the investment decisions. The second tests the impact of the three components of

intellectual capital separately on investment decisions. Model (4) is presented as follows:

$$INV_{it} = \beta_0 + \beta_1 IC_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad \text{(4-1)}$$

$$INV_{it} = \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 SCE_{it} + \alpha_3 CEE_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad \text{(4-2)}$$

## 6-Empirical results and discussion

Table (3) reports the descriptive statistics for the research sample. The main indicator for the intellectual capital records -3.787 as minimum and 194 as a maximum with 9.5 average, which indicates the high variation in the sample, which is assured by large standard deviation, equals 16.12.

The same descriptive results are obtained for the HCE and CEE. The minimum value are (.198, -4.03), and (189.7, 94.95) as maximum with an average value (8.1, .808) and standard deviation equals (15.46, 4.43) respectively. While SCE has a normal descriptive with minimum and maximum values (-4.03, .994), the mean and standard deviation record (.611, 384) respectively. The same results are obtained for the alternative indicators of the intellectual capital and its components.

**Table (3)**
**Descriptive statistics**

| Variables | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| IC | 553 | -3.78724420 | 194.19222860 | 9.55820027 | 16.121981 |
| HCE | 553 | .19868777 | 189.72837 | 8.138747809 | 15.46478703 |
| SCE | 553 | -4.03302227 | .994729307 | .61140031 | .384996651 |
| CEE | 553 | .0077178767 | 94.95083924 | .80805215202 | 4.43504683 |
| Financial leverage | 553 | .000876592 | .9945913044 | .425901694 | .218192039 |
| CFO | 553 | -.5895475966 | .5626294209 | .056893536 | .1235598453 |
| Firm size | 553 | 7.49215301 | 10.814871864 | 8.81106008 | .643869504 |
| Liquidity | 553 | .16527213 | 150.282158836 | 3.30678011 | 10.02109241 |
| Age | 553 | 1.0 | 113.0 | 33.837 | 19.8218 |
| Revenue/employee | 553 | 240240.00 | 11507172.7687 | 867814.74845 | 1495707.183 |
| Earnings/employee | 553 | -508005.7885 | 2339025.2258 | 97149619.265669 | 175677.430860 |
| Asset productivity | 553 | .000208292 | 6.4231723065 | .75977939812 | .7823973628 |
| Investment decisions | 553 | .000119355 | .94878635121 | .227833199 | .203258866 |
| Employees number | 533 | 15.0 | 45781.0 | 2235.239 | 4990.0360 |

For the employee productivity, the descriptive results indicates a big difference between the minimum and maximum values (240240 and 11507172) with an average and standard deviation equal (867814, 1495707) respectively and that may be referred to the large range in the employee number from 15 to 45781 employees. The maximum and average values for asset productivity and investments decisions are (6.4, .94) and (.75, .22) respectively.

The mean values (.42, 8.8, and 33.8) are larger than the standard deviation (.21, .64, and 19.8) for the financial leverage, firm size and firm age respectively. The remaining control variables related to CFO and liquidity recorded some variations in their mean values (.05, and

3.3) comparing with their standard deviations (.123, and 10.02) respectively.

**Table (4)**

| Variables | IC | HCE | SCE | CEE | Fin. | CFO | F.Size | LIQ | Age | R/E | E/E | Ass.T | INV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IC | 1 | | | | | | | | | | | | |
| HCE | .961*** | 1 | | | | | | | | | | | |
| SCE | .358*** | .364 | 1 | | | | | | | | | | |
| CEE | .251*** | -.023 | -.055 | 1 | | | | | | | | | |
| Fin. | .037 | -.089** | -.111*** | .187*** | 1 | | | | | | | | |
| CFO | .019 | .041 | .205*** | -.089** | -.139*** | 1 | | | | | | | |
| Firm size | .067 | .060 | .210*** | .015 | .263*** | .143*** | 1 | | | | | | |
| Liquidity | -.033 | -.026 | .037* | -.031 | -.314*** | -.073* | -.201*** | 1 | | | | | |
| Age | .061 | -.063 | -.103** | .007 | .068 | .069 | .123*** | -.108** | 1 | | | | |
| R/E | .144*** | .149*** | .244*** | -.014 | .046 | -.096** | .372*** | -.059 | -.141*** | 1 | | | |
| E/E | .377*** | .391*** | .374*** | -.026 | -.021 | .203*** | .316*** | -.026 | .014 | .580*** | 1 | | |
| Ass.T | -.160*** | -.193*** | -.133*** | -.106** | .226*** | .137*** | -.032 | -.114** | .056 | .207*** | -.103** | 1 | |
| INV | -.102** | -.099** | -.189*** | -.010 | -.184*** | .051 | -.151*** | -.110** | .010 | -.041 | -.129*** | .037 | 1 |

*** Correlation is significant at the level 0.01 level (2-tailed).

** Correlation is significant at the level 0.05 level (2-tailed).

* Correlation is significant at the level 0.10 level (2-tailed).

**Correlation matrix**

Table (4) represents the strength and direction of the relationship between all the research variables. There is a significant positive correlation between the intellectual capital and its three components, whereas the strongest correlation is between the intellectual capital and human efficiency (.961), and it indicates that the three components are alternative measures for the intellectual capital.

As shown by the table, there is a significant positive correlation between IC, HCE, and SCE and the two proxies of the employee productivity.

As shown in table (4); there is a significant negative correlation between the independent variables and both asset turnover and investment decisions. While, the third component CEE has a significant negative correlation with asset turnover only. For the two employee productivity measurements, there is a significant positive correlation showing that they are alternatives proxy for each other. There is a significant negative relationship between earning per employee and both of asset productivity and investment decisions showing that an increasing in employee productivity may be decreased the asset turnover and the investment in fixed assets. No significant association is found between asset turnover and investment decisions.

Table (5) shows the variance inflation factor for the research variables. As showed from the table, all values are less than 10 for all regression models and which indicates inexistence of multi-collinearity problem between the variables.

The relationship between the intellectual capital and employee productivity will be tested using two measurements for the intellectual capital (the total of the intellectual capital and its three main components) and two measurements for the employee productivity (revenues per employee and earnings per employee).

**Table (5)**
**The variance inflation factor (VIF) for the regression results**

| Variables | Model (1-1) Revenue/ employee | Model (1-2) Revenue/ employee | Model(2-1) Earnings/ employee | Model(2-2) Earnings/ employee | Model(3-1) Asset productivity | Model(3-2) Asset productivity | Model (4-1) Investment decisions | Model (4-2) Investment decisions |
|---|---|---|---|---|---|---|---|---|
| IC | 1.239 | | 1.239 | | 1.239 | | 1.239 | |
| HCE | | 1.443 | | 1.443 | | 1.443 | | 1.443 |
| SCE | | 1.445 | | 1.445 | | 1.445 | | 1.445 |
| CEE | | 1.084 | | 1.084 | | 1.084 | | 1.084 |
| Financial leverage | 1.367 | 1.465 | 1.367 | 1.465 | 1.367 | 1.465 | 1.367 | 1.465 |
| CFO | 1.171 | 1.209 | 1.171 | 1.209 | 1.171 | 1.209 | 1.171 | 1.209 |
| Firm size | 1.390 | 1.500 | 1.390 | 1.500 | 1.390 | 1.500 | 1.390 | 1.500 |
| Liquidity | 1.717 | 1.724 | 1.717 | 1.724 | 1.717 | 1.724 | 1.717 | 1.724 |
| Age | 1.258 | 1.288 | 1.258 | 1.288 | 1.258 | 1.288 | 1.258 | 1.288 |

The first regression model (1-1) is related to the whole impact of the intellectual capital on revenue per employee ratio. As shown by table (6) that p- value equals .000 which is less than .05 and adjusted $R^2$ is 40.5%, which it is considered as reasonable value for explaining that the changes happened in the employee productivity can be referred the independents variables. The intellectual capital as whole has a significant positive impact on employee productivity as it presented by p-value that equals .000 and positive sign for beta .133, and that result supports the first main hypothesis $H_1$.

**Table (6)**
**Regression results for the impact of intellectual capital on employee productivity**

| Variables | Model (1-1) revenue per employee | | | Model (1-2) revenue per employee | | | Model (2-1) Earning per employee | | | Model (2-2) Earning per employee | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Beta | t | Sig | Beta | t | Sig | Beta | t | Sig | Beta | t | Sig |
| IC | .133 | 3.628 | .000 | | | | .285 | 7.726 | .000 | | | |
| HCE | | | | .120 | 3.060 | .002 | | | | .263 | 6.647 | .000 |
| SCE | | | | .074 | 1.891 | .059 | | | | .111 | 2.793 | .005 |
| CEE | | | | -.005 | -.148 | .882 | | | | .020 | .587 | .557 |
| Financial leverage | -.066 | -1.717 | .087 | -.046 | -1.155 | .249 | -.105 | -2.715 | .007 | -.077 | -1.922 | .055 |
| CFO | .029 | .806 | .421 | .014 | .399 | .690 | .123 | 3.435 | .001 | .103 | 2.837 | .005 |
| Firm size | .327 | 8.438 | .000 | .305 | 7.613 | .000 | .266 | 6.790 | .000 | .235 | 5.819 | .000 |
| Liquidity | -.241 | -5.606 | .000 | -.246 | -5.714 | .000 | -.033 | -.748 | .455 | -.039 | -.904 | .366 |
| Age | -.131 | -3.563 | .000 | -.119 | -3.213 | .001 | -.017 | -.466 | .641 | .000 | -.006 | .995 |
| Adjusted $R^2$ | 40.5% | | | 40.8% | | | 39.2% | | | 40.2% | | |
| Model Significant | .000 | | | .000 | | | .000 | | | .000 | | |
| N | 553 | | | 553 | | | 553 | | | 553 | | |
| F-statistic | 16.020 | | | 15.098 | | | 15.256 | | | 14.716 | | |
| Industry effect | Yes | | | Yes | | | Yes | | | Yes | | |
| Year effect | Yes | | | Yes | | | Yes | | | Yes | | |

Firm size has a significant positive association with employee productivity whereas p- value and beta equals (.000 and .327) respectively. Liquidity and firm age have a significant negative association with revenue per employee ratio. The financial leverage has a negative impact at 90% confidence level. While, the CFO is insignificant with employee productivity.

The second regression model (1-2) is related to the impact of the intellectual capital's components on the employee productivity

measured by revenue per employee ratio. The model is significant with a small increase in the adjusted $R^2$ which reached 40.8%. The p- values and beta are (.002, .120) for the human capital efficiency. As well as, the two values are (.059, .074) for the structural capital efficiency, which means that the two component have a significant positive impact on the dependent variable. These results support both the first and second sub- hypotheses $H_{1\text{-}a}$ and $H_{1\text{-}b}$. The third component has no impact on the employee productivity, which means that third sub-hypothesis is rejected $H_{1\text{-}c.}$ The same results are obtained for all the control variables except the financial leverage which has insignificant impact.

Continuing with table (6), model (2-1) and model (2-2) tests; the impact of the total IC and its components on employee productivity measured by earning per employee. The adjusted $R^2$ for these two models are 39.2% and 40.2% respectively. The p- value and beta coefficient are (.000, .285) for the intellectual capital, (.000, 0.263) for the human capital efficiency, and (.005, .111) for the SCE respectively. The results support the acceptance of the main hypothesis $H_2$ and the sub- hypotheses $H_{2\text{-}a}$ and $H_{2\text{-}b.}$

The hypotheses of the capital-employed efficiency ($H_{1\text{-}c}$ and $H_{2\text{-}c}$) are not supported in the four models. The firm size and CFO ratio have a significant positive impact on earnings per employee, while financial

leverage has a negative association. Both liquidity and age are insignificant.

**Table (7)**
**Results for the impact of intellectual capital on Asset productivity**

| Variables | Model (3-1) Asset productivity | | | Model (3-2) Asset productivity | | |
|---|---|---|---|---|---|---|
| | Beta | t | Sig | Beta | t | Sig |
| IC | -.002 | -.051 | .959 | | | |
| HCE | | | | .010 | .241 | .810 |
| SCE | | | | -.038 | -.928 | .354 |
| CEE | | | | .001 | .025 | .980 |
| Financial leverage | .323 | 8.054 | .000 | .318 | 7.653 | .000 |
| CFO | .151 | 4.067 | .000 | .157 | 4.146 | .000 |
| Firm size | -.132 | -3.254 | .001 | -.121 | -2.878 | .004 |
| Liquidity | -.192 | -4.261 | .000 | -.189 | -4.188 | .000 |
| Age | .094 | 2.428 | .016 | .088 | 2.261 | .024 |
| Adjusted $R^2$ | 34.9% | | | 34.7% | | |
| Model Significant | .000 | | | .000 | | |
| N | 553 | | | 553 | | |
| F-statistic | 12.815 | | | 11.872 | | |
| Industry effect | Yes | | | Yes | | |
| Year effect | yes | | | Yes | | |

The model (3-1) tests the effect of the intellectual capital as whole on asset productivity. Table (7) presents the significance of the model (p- value= .000) and adjusted $R^2$ of 34.9%. There is an insignificant association between the two variables. This means that the third main hypothesis ($H_3$) is rejected.

In contrast, all control variables have a significant positive association with the asset turnover except firm size and liquidity which they have a significant negative impact on asset productivity.

Moving to test the components of the intellectual capital to clarify which components has a significant association with asset productivity. Results for model (3-2) shows that p-value equals .000 and adjusted $R^2$ 34.7%. On the same direction, there is no relationship between the three components of intellectual capital, which means that the three sub- hypotheses ($H_{3-a}$, $H_{3-b}$, and $H_{3-c}$) are rejected. While all the control variables have a significant effect on asset productivity. Firm size and liquidity have a significant negative impact on asset productivity, but the remaining control variables have a significant positive impact on asset productivity.

The regression model (4-1) examines the effect of the intellectual capital including all components on investment decisions. Table (8) presents the significance of the model (p- value= .000) and adjusted $R^2$ of 23.7%. The intellectual capital has a significant negative effect on investment decisions, which supports the fourth main hypothesis ($H_4$). Control variables; financial leverage, firm size and liquidity have a significant negative impact on investment decisions. While the control variables; firm age and CFO ratio have insignificant association with the dependent variable.

**Table (8)**
**Results for the impact of intellectual capital on investment decisions**

| Variables | Model (4-1) Investment decisions | | | Model (4-2) Investment decisions | | |
|---|---|---|---|---|---|---|
| | Beta | t | Sig | Beta | t | Sig |
| IC | -.097 | -2.344 | .019 | | | |
| HCE | | | | -.069 | -1.543 | .123 |
| SCE | | | | -.102 | -2.288 | .023 |
| CEE | | | | -.006 | -.167 | .867 |
| Financial leverage | -.152 | -3.486 | .001 | -.169 | -3.771 | .000 |
| CFO | .039 | .959 | .338 | .055 | 1.346 | .179 |
| Firm size | -.190 | -4.331 | .000 | -.162 | -3.561 | .000 |
| Liquidity | -.242 | -4.973 | .000 | -.235 | -4.838 | .000 |
| Age | .012 | .290 | .772 | -.003 | -.062 | .951 |
| Adjusted $R^2$ | 23.7% | | | 24.2% | | |
| Model Significant | .000 | | | .000 | | |
| N | 553 | | | 553 | | |
| F-statistic | 7.862 | | | 7.522 | | |
| Industry effect | Yes | | | Yes | | |
| Year effect | yes | | | Yes | | |

For the intellectual components, results of model (4-2) indicate the p- value= .000) and adjusted $R^2$ 24.2%. The SCE has a significant negative impact on investment decisions, whereas the p-value and coefficient (.023, -.102) respectively. Therefore, the third sub-hypothesis ($H_{4-b}$) is accepted. On the contrary, the findings confirm insignificant association between the remaining two components and investment decisions, whereas their p-values are more than .05. These results do not support the third sub- hypotheses ($H_{4-a}$) and ($H_{4-c}$). The same results are obtained for all the control variables.

Table (9) shows a summary of the research hypotheses' results.

**Table (9)**
**Summary of the research hypotheses' results**

| Hypotheses | Results |
|---|---|
| *$H_1$: There is a significant positive relationship between IC and revenue per employee* | Accepted |
| $H_{1-a}$: There is a significant positive relationship between HCE and revenue per employee. | Accepted |
| $H_{1-b}$: There is a significant positive relationship between SCE and revenue per employee. | Accepted |
| $H_{1-c}$: There is a significant positive relationship between CEE and revenue per employee. | Rejected |
| *$H_2$: There is a significant positive relationship between IC and earning per employee* | Accepted |
| $H_{2-a}$: There is a significant positive relationship between HCE and earning per employee. | Accepted |
| $H_{2-b}$: There is a significant positive relationship between SCE and earning per employee. | Accepted |
| $H_{2-c}$: There is a significant positive relationship between CEE and earning per employee. | Rejected |
| *$H_3$: There is a significant positive relationship between IC and Asset productivity* | Rejected |
| $H_{3-a}$: There is a significant positive relationship between HCE and asset productivity. | Rejected |
| $H_{3-b}$: There is a significant positive relationship between SCE and asset productivity. | Rejected |
| $H_{3-c}$: There is a significant positive relationship between CEE and asset productivity. | Rejected |
| *$H_4$: There is a significant relationship between IC and investment decisions* | Accepted |
| $H_{4-a}$: There is a significant relationship between HCE and investment decisions | Rejected |
| $H_{4-b}$: There is a significant relationship between SCE and investment decisions | Accepted |
| $H_{4-c}$: There is a significant relationship between CEE and investment decisions | Rejected |

## 7-Additional analyses

In this section, the regression tests are reapplied using alternative measurements for the value added. Revenues subtracting by all costs related to achieve those revenues except the salaries and wages expenses (Alipour and Gorgizadeh, 2017), and the same measurements for the three components.

**Model (5): The impact of intellectual capital on employee productivity measured by revenue per employee.**

$$R/E_{it} = \beta_0 + \beta_1 IC1_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad (5\text{-}1)$$

$$R/E_{it} = \alpha_0 + \alpha_1 HCE1_{it} + \alpha_2 SCE1_{it} + \alpha_3 CEE1_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad (5\text{-}2)$$

**Model (6): The impact of intellectual capital on employee productivity measured by earning per employee.**

$$E/E_{it} = \beta_0 + \beta_1 IC1_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad (6\text{-}1)$$

$$E/E_{it} = \alpha_0 + \alpha_1 HCE1_{it} + \alpha_2 SCE1_{it} + \alpha_3 CEE1_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad (6\text{-}2)$$

**Model (7): The impact of intellectual capital on asset productivity**

$$Ass/T_{it} = \beta_0 + \beta_1 IC1_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad (7\text{-}1)$$

$$Ass/T_{it} = \alpha_0 + \alpha_1 HCE1_{it} + \alpha_2 SCE1_{it} + \alpha_3 CEE1_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad (7\text{-}2)$$

**Model (8): The impact of intellectual capital on investment decisions**

$$INV_{it} = \beta_0 + \beta_1 IC1_{it} + \beta_2 Leverage_{it} + \beta_3 CFO_{it} + \beta_4 Size_{it} + \beta_5 Liquidity_{it} + \beta_6 Age_{it} + \beta_7 year_{it} + \beta_8 IND_{it} + \varepsilon. \quad \text{(8-1)}$$

$$INV_{it} = \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 SCE_{it} + \alpha_3 CEE_{it} + \alpha_4 Leverage_{it} + \alpha_5 CFO_{it} + \alpha_6 Size_{it} + \alpha_7 Liquidity_{it} + \alpha_8 Age_{it} + \alpha_9 year_{it} + \alpha_{10} IND_{it} + \varepsilon. \quad \text{(8-2)}$$

Table (10) shows the variance inflation factor for the research variables as showed by the table whereas all values are less than 10 for all regression models and which presents inexistence of multi-collinearity problem between the variables.

**Table (10)**
**The variance inflation factor (VIF) for the alternative tests**

| Variables | Model (5-1) Revenue/ employee | Model (5-2) Revenue/ employee | Model (6-1) Earnings/ employee | Model (6-2) Earnings/ employee | Model (7-1) Asset productivity | Model (7-2) Asset productivity | Model (8-1) Investment decisions | Model (8-2) Investment decisions |
|---|---|---|---|---|---|---|---|---|
| IC1 | 1.191 | | 1.191 | | 1.191 | | 1.191 | |
| HCE1 | | 1.416 | | 1.416 | | 1.416 | | 1.416 |
| SCE1 | | 1.055 | | 1.055 | | 1.055 | | 1.055 |
| CEE1 | | 1.080 | | 1.080 | | 1.080 | | 1.080 |
| Financial leverage | 1.353 | 1.425 | 1.353 | 1.425 | 1.353 | 1.425 | 1.353 | 1.425 |
| CFO | 1.176 | 1.191 | 1.176 | 1.191 | 1.176 | 1.191 | 1.176 | 1.191 |
| Firm size | 1.386 | 1.393 | 1.386 | 1.393 | 1.386 | 1.393 | 1.386 | 1.393 |
| Liquidity | 1.717 | 1.717 | 1.717 | 1.717 | 1.717 | 1.717 | 1.717 | 1.717 |
| Age | 1.259 | 1.264 | 1.259 | 1.264 | 1.259 | 1.264 | 1.259 | 1.264 |

The models (5-1) and (6-1) are related to the whole impact of the intellectual capital using alternative measurement on employee productivity measured by the two proxies. As shown by table (11); the p- value equals .000 for the two models and adjusted $R^2$ are 39.4% and 37.7% respectively in the models, it is considered the same result obtained in the main analysis. The intellectual capital as whole has a significant positive impact on employee productivity.

**Table (11)**
**Regression results for the impact of intellectual capital on employee productivity**

| Variables | Model (5-1) revenue per employee | | | Model (5-2) revenue per employee | | | Model (6-1) Earning per employee | | | Model (6-2) Earning per employee | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Beta | t | Sig | Beta | t | Sig | Beta | t | Sig | Beta | t | Sig |
| IC1 | .071 | 1.962 | .050 | | | | .246 | 6.718 | .000 | | | |
| HCE 1 | | | | .088 | 2.243 | .025 | | | | .317 | 8.075 | .000 |
| SCE 1 | | | | .012 | .349 | .727 | | | | .012 | .363 | .716 |
| CEE 1 | | | | -.003 | -.078 | .938 | | | | .024 | .707 | .480 |
| Financial leverage | -.078 | -2.028 | .043 | -.068 | -1.730 | .084 | -.128 | -3.286 | .001 | -.099 | -2.523 | .012 |
| CFO | .028 | .769 | .442 | .025 | .697 | .486 | .114 | 3.136 | .002 | .110 | 3.063 | .002 |
| Firm size | .333 | 8.541 | .000 | .334 | 8.548 | .000 | .274 | 6.932 | .000 | .282 | 7.236 | .000 |
| Liquidity | -.244 | -5.632 | .000 | -.243 | -5.604 | .000 | -.041 | -.925 | .355 | -.036 | -.840 | .401 |
| Age | -.136 | -3.661 | .000 | -.133 | -3.569 | .000 | -.019 | -.517 | .606 | -.009 | -.254 | .800 |
| Adjusted $R^2$ | 39.4% | | | 39.4% | | | 37.7% | | | 39.8% | | |
| Model Significant | .000 | | | .000 | | | .000 | | | .000 | | |
| N | 553 | | | 553 | | | 553 | | | 553 | | |
| F-statistic | 15.380 | | | 14.284 | | | 14.355 | | | 14.528 | | |
| Industry effect | Yes | | | Yes | | | Yes | | | Yes | | |
| Year effect | Yes | | | Yes | | | Yes | | | Yes | | |

In addition, models (5-2) and (6-2) confirm a significant positive association between human capital efficiency and employee productivity at 95% confidence level, and an insignificant association between the SCE and CEE as independent variables and employee productivity as dependent variable.

Models (5-2) and (6-2) are related to the impact of the intellectual capital's components on the employee productivity. The model is significant with adjusted $R^2$ reached to 39.4% and 39.8% respectively. The human capital efficiency has a significant positive impact on the dependent variable as both p- values and beta coefficients are (.025, .088) and (.000, .317) for the two models respectively. The impact of human capital is increased in the second model.

The seventh regression model tests the effect of the intellectual capital on asset productivity. Table (12) presents ted that the two models are significance (p- value= .000) and adjusted $R^2$ are 34.9% and 34.7% respectively. No significant relationship are reported between the main independent variable and the dependent variable. In contrast, all control variables have a significant positive association with the asset turnover except firm size and liquidity which they have a significant negative impact on asset productivity.

**Table (12)**
**Results for the impact of intellectual capital on Asset productivity**

| Variables | Model (7-1) Asset productivity | | | Model (7-2) Asset productivity | | |
|---|---|---|---|---|---|---|
| | Beta | t | Sig | Beta | t | Sig |
| IC 4 | -.013 | -.353 | .724 | | | |
| HCE (main) | | | | -.035 | -.867 | .386 |
| SCE (main) | | | | .015 | .438 | .662 |
| CEE (main) | | | | .007 | .194 | .846 |
| Financial leverage | .323 | 8.090 | .000 | .317 | 7.727 | .000 |
| CFO | .152 | 4.083 | .000 | .153 | 4.078 | .000 |
| Firm size | -.131 | -3.244 | .001 | -.133 | -3.270 | .001 |
| Liquidity | -.192 | -4.257 | .000 | -.192 | -4.271 | .000 |
| Age | .093 | 2.402 | .017 | .090 | 2.340 | .020 |
| Adjusted $R^2$ | 34.9% | | | 34.7% | | |
| Model Significant | .000 | | | .000 | | |
| N | 553 | | | 553 | | |
| F-statistic | 12.823 | | | 11.875 | | |
| Industry effect | Yes | | | Yes | | |
| Year effect | Yes | | | Yes | | |

Table (13) represents the results of the effect of the intellectual capital on investment decisions. Model (8-1) is significant (p- value= .000) and adjusted $R^2$ 23.9%. The significance column for each variable shows significant negative association between the intellectual capital as whole and the investment decisions. For the control variables, the firm age only has insignificant association with the dependent variable. On the other side, the remaining control variables have a significant negative association with the investment decisions except CFO and age which they have a significant positive relationship.

**Table (13)**
**Results for the impact of intellectual capital on investment decisions**

| Variables | Model (8-1) Investment decisions | | | Model (8-2) Investment decisions | | |
|---|---|---|---|---|---|---|
| | Beta | t | Sig | Beta | t | Sig |
| IC 1 | -.107 | -2.640 | .009 | | | |
| HCE 1 | | | | -.148 | -3.361 | .001 |
| SCE 1 | | | | .005 | .136 | .892 |
| CEE 1 | | | | -.009 | -.224 | .823 |
| Fin. leverage | -.144 | -3.345 | .001 | -.159 | -3.599 | .000 |
| CFO | .043 | 1.077 | .282 | .045 | 1.116 | .265 |
| Firm size | -.191 | -4.381 | .000 | -.196 | -4.476 | .000 |
| Liquidity | -.239 | -4.916 | .000 | -.241 | -4.973 | .000 |
| Age | .011 | .259 | .796 | .006 | .136 | .892 |
| Adjusted $R^2$ | 23.9% | | | 24.3% | | |
| Model Significant | .000 | | | .000 | | |
| N | 553 | | | 553 | | |
| F-statistic | 7.942 | | | 7.552 | | |
| Industry effect | Yes | | | Yes | | |
| Year effect | Yes | | | Yes | | |

The intellectual capital components results for model (8-2) indicates the p- value= .000) and adjusted $R^2$ 24.3%. The model represents a significant negative impact of human capital efficiency on investment decisions, which differs from the main test; and the SCE is replaced by HCE.

For the other two components of the intellectual capital, there is insignificant relationship between these two components and investment decisions. Moreover, model (8-2) shows the same results for the control variables.

## 8- Conclusion

The research results present the main conclusion that there is a significant relationship between total IC and employee productivity measured by both the revenue per employee ($H_1$), and earnings per employee ($H_2$). The IC is then decomposed into three components; the HCE, and SCE which they are found to have a significant positive impact on EP measured by revenue per employee ($H_1$) and earnings per employee ($H_2$), while CEE has a significant positive impact on EP measured by revenue per employee ($H_1$) only.

These results show that the IC is based mainly on EP and on the employee acceptance for the new technology and the system the company is applying. The man power has become one of the main and essential key controllers that have been applied today side by side with AI in the fifth industrial revolution. In addition, IC is not affected by asset productivity, therefore $H_3$ is rejected. These results supports the notion that IC is not considered as accounting asset in the financial statements and it represents only about 20% of its actual value due to measurement issues and estimation (Ismail 2020).

The results found a negative significant association between total IC and investment decisions, while when the researchers decomposed the IC into the three components; it is found that the only component that negatively affects IC significantly is SCE. SCE as explained before is concerned with non-human capital such as capital

related to innovations. These results supports the notion that innovations and technology related intangibles are still not considered by most companies although they are considered the cornerstone for any investment decisions especially nowadays. Value creation theory depends more on the technology and innovation, therefore investment decisions should add value to shareholders through IC investment and then firm value will increase.

This paper merger between two important topics for managerial accounting by focusing on the intellectual capital and productivity and financial accounting through the investment decisions. It evaluates the performance of the tangible and intangible assets, which contributes to minimize the gap and provides evidence depending on using intangible indicators beside tangible indicators.

The previous studies focused on testing the relationship between the intellectual capital and financial performance. And there is a shortage in studies that focused on the productivity especially in the Middle East. This paper provides an empirical evidence depending on large sample (554 observations) for nine years from 2012 to 2019, according to the availability of data in the Egyptian stock market.

The research study recommends the accounting bodies and the companies applying new technology to focus more on the employees and their satisfaction regarding any new system and technology to apply. Employee training and acceptance are essential. Employee resistance may negatively affect the whole company productivity. The research recommends the accounting and standards setting boards to work more on the IC (intangibles) measures especially the future value of the assets and the consistency or the recording under taking conservatism in our consideration. It is important to increase the awareness regarding investment decisions on technology and human capital at all levels.

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