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The Industrial Revolution 4.0, Societal Well-Being and Firms Performance among Malaysian Listed Companies

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ABSTRACT

In today's competitive economic landscape, companies around the world face mounting pressure to innovate and incorporate cutting-edge technology, particularly Industry 4.0 (IR4), into their operations. As a result, investing in the development and adoption of advanced IR4 technology has become increasingly crucial for businesses looking to remain competitive. Additionally, there is growing demand for companies to prioritize their responsibilities to society, including improving their workforce, upholding human rights, supporting local communities, and ensuring product safety and reliability. In light of these factors, it is important to investigate the relationship between a company's commitment to Industry 4.0 (IR 4.0) and societal well-being with the overall firm performance. This study examines a sample of 309 firm-year observations from publicly listed companies in Malaysia between 2010 and 2018, utilizing data from the Refinitiv database and employing multiple regression analysis. The results of the study demonstrate a positive association between a company's commitment to IR 4.0 and societal well-being with its overall firm performance. Further analysis also shows that individual components of social scores, such as workforce, human rights, community, and product responsibility, have a positive impact on firm performance. The findings of this study offer valuable insights to investors and policymakers, suggesting that a company's commitment to adopting digital technology and promoting societal well-being can lead to improved performance.

1. Introduction

The Industrial revolution 4.0 (IR4.0), is a transformative process that integrates advanced technologies such as artificial intelligence, robotics, the Internet of Things (IoT), and big data analytics into manufacturing and other industries. The introduction of IR4.0 in Malaysia has been a national agenda for the past few years, with the government actively promoting and implementing initiatives to drive the country's digital transformation. In Malaysia, the government has established the National Policy on Industry 4.0, which serves as a roadmap to guide the country's digital

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transformation [1]. The policy aims to create a competitive and sustainable economy, driven by technology and innovation, with a focus on increasing productivity and creating high-skilled jobs. To facilitate the adoption of IR4.0, the Malaysian government has launched several initiatives, including the Industry4WRD program, which provides incentives and grants to help businesses to adopt and implement IR4.0 technologies. The program also offers training and upskilling programs to assist employees in adapting to the new technologies.

Furthermore, Malaysia has also established the Digital Free Trade Zone (DFTZ), a joint venture between the Malaysian government and China's Alibaba Group, to facilitate cross-border e-commerce transactions and support SMEs in reaching global markets [2]. The DFTZ leverages on IR4.0 technologies, such as big data analytics and cloud computing, to provide a seamless and efficient platform for businesses to conduct transactions. It is clear that the introduction of IR4.0 in Malaysia is a national priority, with the government actively promoting and implementing initiatives to drive the country's digital transformation. These efforts aim to create a competitive and sustainable economy, driven by technology and innovation, with a focus on increasing productivity and creating high-skilled jobs.

As Malaysia transitions into the new economy, businesses must adapt and innovate to keep up with the rapid changes brought about by Industrial Revolution 4.0 (IR 4.0). This paradigm shift involves the integration of digital technology and automation to make processes smarter and more efficient [3]. The concept of IR 4.0 originated in Germany as a strategic initiative to provide advanced manufacturing solutions, and it has since become a global phenomenon. The business landscape in Malaysia has undergone a significant shift towards digital technology investment, as the country seeks to achieve advanced nation status and promote societal well-being. The Fourth Industrial Revolution, or IR 4.0, has been at the forefront of this transformation, offering businesses the potential to improve their operations, decision-making, and ultimately, their performance. However, as technology continues to advance, concerns have arisen over the potential displacement of jobs and the impact on society. Costly investment in IR4.0 technology also raises the issue of whether it is worth it, in the sense that it could at least increase firm profitability and performance. As such, there is a growing need to examine whether the investment on IR 4.0 and firms commitments on societal well-being are really beneficial to business and results in better firm performance. Therefore, this study examines the following objectives: (1) whether IR4.0 is associated with greater firm performance, and (2) whether societal well-being could positively influence firm performance.

The impact of IR4.0 and societal well-being can be explained by the legitimacy theory. The theory suggests that businesses should operate in a way that is perceived as legitimate by the society in which they operate [4]. In other words, businesses need to maintain a positive image in the eyes of their stakeholders and the public in order to continue to operate successfully. Legitimacy theory is based on the idea that a business's long-term success is dependent on its ability to meet the expectations and demands of society. This means that businesses must not only focus on financial performance, but also on their social and environmental impact. By doing so, they can build and maintain a strong reputation, which can lead to increased stakeholder support and trust. Legitimacy theory suggests that businesses can enhance their legitimacy by being transparent about their activities and by engaging with their stakeholders. This means that businesses should communicate openly with their stakeholders and involve them in decision-making processes. Additionally, businesses should be responsive to the concerns and expectations of their stakeholders and take action to address any issues that arise. Overall, legitimacy theory emphasizes the importance of a business's social and environmental performance, and highlights the need for businesses to be accountable to their stakeholders in order to maintain their legitimacy and ensure long-term success.

The implementation of Industry 4.0 (IR4.0) technologies can have a positive impact on a firm's performance from the perspective of legitimacy theory. The adoption of IR4.0 technologies can enhance a firm's legitimacy by improving its social and environmental performance. For example, the implementation of IR4.0 technologies can lead to increased efficiency, reduced waste, and improved safety, which can help a firm to meet the expectations and demands of its stakeholders. This, in turn, can enhance the firm's reputation and legitimacy in the eyes of its stakeholders.

The relationship between IR4.0 implementations and firm performance from the perspective of legitimacy theory depends on the extent to which a firm is able to align its implementation of IR4.0 technologies with societal expectations and values. If a firm is able to do so, it can enhance its legitimacy and improve its long-term performance. When a firm demonstrates a commitment to societal well-being, it can enhance its legitimacy in the eyes of its stakeholders. For example, a firm that adopts environmentally sustainable practices, engages in community outreach programs, or ensures ethical labor practices can be seen as socially responsible and caring about the well-being of society. This, in turn, can lead to increased stakeholder trust, loyalty, and support, which can benefit the firm's financial performance in the long run. Additionally, a firm's commitment to societal well-being can also improve its access to resources, including capital, customers, and employees. For example, firms that are seen as socially responsible may attract socially conscious investors or customers, which can increase sales and profits. Similarly, firms that prioritize the well-being of their employees may attract and retain talented and motivated workers, which can enhance productivity and innovation. However, it is important to note that a firm's commitment to societal well-being must be perceived as genuine and aligned with societal expectations in order to enhance its legitimacy and performance. If a firm's commitment is perceived as superficial or insincere, it may actually harm its legitimacy and performance in the long run. Therefore, a genuine and authentic commitment to societal well-being can enhance a firm's legitimacy and improve its long-term performance based on legitimacy theory.

Another theory that underpinned this study is the signaling theory. The theory suggests that managers may engage in behaviors or actions that provide information about their abilities, motivations, or intentions to others in order to gain advantages or reduce information asymmetry [5]. The implementation of Industry 4.0 (IR4.0) technologies can have positive impacts on a firm's performance from the perspective of signaling theory. The adoption of IR4.0 technologies can serve as a signal of a firm's competitiveness, innovation, and commitment to continuous improvement. By implementing advanced technologies, firms can signal to customers, suppliers, and investors that they are able to provide high-quality products or services at a lower cost, which can lead to increased sales and profits. Additionally, the adoption of IR4.0 technologies can signal a firm's willingness to invest in long-term growth, which can attract new investors and increase the firm's stock price.

Similarly, signaling theory also suggests that a firm's commitment to societal well-being can also have a positive impact on its performance by serving as a signal of its competitiveness and long-term viability. By demonstrating a commitment to societal well-being, a firm can signal to its stakeholders, including customers, employees, investors, and the wider community, that it is able to provide high-quality products or services while also contributing to the well-being of society. For example, a firm that adopts environmentally sustainable practices or engages in social responsibility initiatives can signal to its customers that it is committed to providing high-quality products or services while also reducing its environmental impact or contributing to society. This can lead to increased customer loyalty and sales, as well as positive word-of-mouth recommendations. Additionally, a firm's commitment to societal well-being can also attract and retain talented and motivated employees who are attracted to firms that align with their values and principles. This, in turn, can enhance productivity and innovation, which can improve the firm's short and long-term performance.

Furthermore, a firm's commitment to societal well-being can also attract socially conscious investors who are interested in investing in firms that are aligned with their values and priorities. This can increase the firm's access to capital and lead to increased financial performance.

Using the Ordinary Least Square (OLS) regression, this study documented that both IR 4.0 and firms' commitment on societal well-being are positively related to firms financial performance. In other words, the study found that firms that implement IR4.0 technology have generated more profit compared to their counterparts. In addition, firms that are more committed towards their societal well-being achieved greater firms performance.

As research examining the relationship between IR4.0, societal well-being and firms performance is still scarce, this study makes both practical and theoretical contributions to the field of accounting and finance. In terms of practical contribution, the findings of this study can provide insights into the potential impact of IR 4.0 and societal well-being harmonization on firm performance. The study can help policymakers and practitioners develop strategies that promote sustainable economic growth while also considering the impact on society. Additionally, the study can help firms navigate the challenges and opportunities of the new economy while promoting social responsibility and sustainability in achieving optimal firm performance.

In terms of theoretical contribution, this study contributes to the literature by integrating signaling and legitimacy theories to examine the impact of IR 4.0 and societal well-being harmonization on firm performance. The study provides a comprehensive framework for understanding the potential impact of these two factors on firm performance, which can contribute to the development of new theoretical models and frameworks in the field of accounting and finance. The study also extends prior research on the impact of technology and social responsibility on firm performance by examining the combined effect of IR 4.0 and societal well-being harmonization on firm performance, which is a novel contribution to the field.

The remainder of this paper is divided into 4 sections. The next section reviews the relevant literature and presents the hypothesis development. Section 3 discusses the methodology used in this study. Section 4 presents the findings and discussions, and the final section concludes the study with implications for future research.

2. Literature and Hypothesis Development

2.1 The Industrial Revolution

Extant literature documented that Industrial revolution 4.0 seems to have led to an improvement in firm performance. Studies conducted by [6-9] have found that Industrial Revolution 4.0 (IR 4.0) plays a major role in improving organisational performance by promoting production and services. Ślusarczyk *et al.,* [10] examined the role of IR 4.0 on the performance of firms engaged in the production and services of the Malaysian textile industry. Their results found that IR 4.0 which has a positive role in the firm performance contributes to the effectiveness of the production and services of textile industry. Adanan and Rasid [11] highlighted that digital transformation along with operational capabilities increases business performance and helps maintain competitive advantage. According to Saleh *et al.,* [12], digitalisation of technology such as transformation to digital platforms was found to increase the efficiency and productivity of business operations, leading to better firms performance.

In addition, Jermsittiparsert and Boonratanakittiphumi [13] conducted research on KPMG in Thailand to examine the impact of Industrial Revolution 4.0 (IR 4.0) on the relationship between knowledge management capability and firm performance. The study found that process and technological capabilities, as key components of knowledge management, can impact supply chain

management practices. The researchers concluded that IR 4.0, with its high process and technological capabilities, facilitates knowledge sharing among organizational employees and different organizations to create customer value. Another benefit of IR4 technologies is improved quality and consistency. By monitoring and analyzing data in real-time, firms can identify and correct issues quickly, leading to better quality and consistency of products and services. For example, in the healthcare industry, IR4 technologies can be used to monitor patient health data, enabling healthcare providers to detect and respond to health issues quickly, improving patient outcomes and reducing healthcare costs.

IR4 technologies also offer increased flexibility and customization, enabling firms to respond quickly and effectively to changing customer demands, as well as offer more personalized and customized products and services. For example, in the retail industry, IR4 technologies can be used to analyze customer data, enabling retailers to provide personalized recommendations and offers to customers, leading to increased customer loyalty and revenue. Moreover, IR4 technologies can also enable better decision-making by providing firms with access to large amounts of data. By analyzing this data, firms can make more informed decisions and optimize their operations, leading to improved performance and profitability. For example, IR4 technologies can be used to analyze customer data and financial markets, enabling firms to make better investment decisions and reduce risk. IR4 technologies can also enhance the customer experience, enabling firms to provide a more seamless and personalized customer experience, leading to increased customer satisfaction and loyalty.

From the above theoretical and empirical arguments, we propose the following hypothesis:
H1: There is a positive relationship between IR 4.0 and firms' performance among Malaysian listed companies

2.2 Societal Well-Being

As most investors are now placing a greater emphasis on societal well-being when making investment decisions, socially responsible companies prioritize both their financial goals and their impact on society and the environment. According to numerous studies, a company's ESG scores, which evaluate its social performance, are linked to its overall performance [14-16].

Research has shown that socially responsible companies not only perform well financially but also have a positive impact on society and the environment [17-19]. There are numerous benefits of being socially responsible. First, it leads to a positive impact on society. Socially responsible companies address social, environmental, and ethical issues, support causes that benefit the community, and improve their reputation and build trust with consumers and stakeholders [20]. Second, it promotes environmental sustainability. Socially responsible companies reduce their environmental impact by using sustainable practices, reducing waste, and promoting renewable energy [21-22]. Third, socially responsible companies are able to attract and retain employees who value working for companies that align with their values and beliefs [21-23]. Finally, socially responsible companies often have a long-term perspective and invest in sustainable practices, innovative technologies, and community development, leading to long-term profitability and success [21-23].

Socially responsible companies can lead to high profits in several ways, such as building a positive brand reputation, reducing costs, improving employee productivity and retention, building better relationships with stakeholders, and promoting innovation [24-25]. Recent studies provide evidence of the positive relationship between social and firm performance [26-29], and employee satisfaction and performance contribute to improving a company's financial performance [30]. Building a focus on social relations can benefit a company by retaining human resources, improving customer

retention, enhancing productivity through environmental management, building better local community relationships, and attracting socially and ethically-minded investors [24-25]. Similarly, Callan and Thomas [31] documented the positive relationship between corporate social practice and corporate financial performance. Busch and Friede [32] demonstrated a highly significant and positive social and financial performance relationship.

The study examines four dimensions of societal well-being, namely workforce issues, human rights, community engagement, and product responsibility. These dimensions align with Berman et al. [33] measure of a company's social responsibility, which includes indicators such as diversity and inclusion, health and safety, product responsibility, community engagement, human rights, employment quality, and training and development.

Based on these discussions the following hypothesis is developed:

H2: There is a positive relationship between societal well-being and firms' performance among Malaysian Listed companies

3. Research Design

3.1 Sample Selection

In this research, we utilized an ESG dataset sourced from Thomson Reuters (Refinitiv), similar to previous studies conducted by [34-36]. Our sample consisted of all firm-year observations from the Refinitiv database of publicly listed Malaysian companies during the period of 2010-2018. This time period was selected as it coincides with the initial stages of IR4 adoption, enabling us to evaluate the actual performance consequences of IR4. We excluded observations from financial institutions (SIC code between 6000 and 6999), including banks, life insurance firms, non-life insurance firms, real estate investment and services, real estate investment trusts, suspended equities, and financial services [37-38]. Additionally, we removed utility firms (SIC code between 4900 and 4999), which are heavily regulated and may differ from other firms with regard to operating decisions [39]. After eliminating observations with incomplete data, our final sample consisted of 309 firm-year observations from 55 unique firms. To reduce the influence of outliers, we winsorized the observations falling in the top and bottom one percent of all continuous variables.

3.2 Measurement for Variables

We measure the dependent variable, firm's performance, using the return on assets (ROA) financial ratio. ROA represents a company's profitability by calculating its net income as a percentage of its total assets. This ratio is an indicator of how efficiently a company is using its assets to generate profits. A higher ROA indicates that a company is more efficient in generating profits with its assets, while a lower ROA may suggest that a company is not utilizing its resources to their fullest potential.

To assess firms' commitment to Industry 4.0 (IR4.0), we collected data from their annual reports, focusing on information related to the adoption or application of IR4.0. The data was collected manually, and a dummy variable was used to represent IR4.0 commitment. The variable was assigned a value of one if the company disclosed any information related to the use of robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology, the internet of things, the industrial internet of things (IIoT), decentralized consensus, fifth-generation wireless technologies (5G), 3D printing, and fully autonomous vehicles applications. If the company did not disclose any information related to IR4.0, the variable was assigned a value of zero.

To measure a company's commitment to societal well-being, we utilized two measurements. First, we used the Social Pillar Score (SOCIAL) of the ESG, which represents an overall measure of

societal well-being, covering all four aspects of the social category. The Social Pillar Score is a weighted average of the four category scores, which are Community, Human Rights, Product Responsibility, and Workforce. The Social Pillar Score ranges from 0 to 100, where a higher score indicates a higher degree of societal well-being. Second, we examined the four categories under the Social Pillar to provide more detailed information on their relationship with the firm's performance. We included all categorical measures for the Social Pillar, which are WORKFORCE, HUMANRIGHTS, COMMUNITY, and PRS, as provided by Refinitiv.

WORKFORCE score is a measure for a company's effectiveness in terms of providing job satisfaction, a healthy and safe workplace, maintaining diversity and equal opportunities, and development opportunities for its workforce. The WORKFORCE score is based on the relative weight calculated from controversy scores gathered from each company. This includes the number of controversies published in the media linked to workforce diversity and opportunity, such as wages, promotion, discrimination, and harassment, the number of controversies published in the media linked to workforce health and safety, the number of controversies published in the media linked to the company's relations with employees or relating to wages or wage disputes, and the occurrence of strikes or industrial disputes that led to lost working days.

HUMANRIGHTS score measures a company's effectiveness in terms of respecting fundamental human rights conventions. Similarly, the HUMANRIGHTS score is based on the relative weight calculated from the number of controversies published in the media linked to the use of child labor issues and human rights issues.

The COMMUNITY score measures a company's commitment to being a good citizen, protecting public health, and respecting business ethics. The score is calculated based on the relative weight of the number of controversies published in the media linked to anti-competitive behavior, such as anti-trust and monopoly, price-fixing, or kickbacks, the number of controversies published in the media linked to business ethics in general, political contributions or bribery and corruption, the number of controversies published in the media linked to patents and intellectual property infringements, the number of controversies published in the media linked to activities in critical, undemocratic countries that do not respect fundamental human rights principles, the number of controversies published in the media linked to public health or industrial accidents harming the health and safety of third parties, and the number of controversies published in the media linked to tax fraud, parallel imports, or money laundering.

The PRS score reflects a company's capacity to produce quality goods and services, integrating the customer's health and safety, integrity, and data privacy. The score is calculated based on the number of controversies published in the media linked to consumer complaints or dissatisfaction directly linked to the company's products or services, the number of controversies published in the media linked to customer health and safety, the number of controversies published in the media linked to employee or customer privacy and integrity, the number of controversies published in the media linked to product access, the number of controversies published in the media linked to the company's marketing practices, such as over-marketing of unhealthy food to vulnerable consumers, and the number of controversies published in the media linked to responsible research and development (R&D).After collecting the data on controversies, and applying the weights for each type of controversies, the companies are sorted from lowest to highest and percentile rank formula is applied to derive to the final scores for WORKFORCE, HUMANRIGHTS, COMMUNITY and PRS.

3.3 Regression Models

We regress the following models to investigate the effect of companies' commitment on adopting IR 4.0 and societal well-being on firm performance. ROAPCT is used as a dependent variable, while IR4 and SOCIAL are employed as the explanatory variables together with other control variables. The multivariate regressions are presented below:

$$ROAPCT_{it} = \beta_0 + \beta_1 IR4_{it} + \beta_2 SOCIAL_{it} + \beta_3 SIZE_{it} + \beta_4 LEV_{it} + \beta_5 GROWTH_{it} + \beta_6 LIQUIDITY_{it} + \beta_7 LITIGATION_{it} + \theta_{1\text{-}n} Fixed\_Effects_t + \varepsilon_{it} \quad (1)$$

where $ROAPCT_{it}$ is computed as the percentage return on assets for firm i in year t; $SOCIAL_{it}$ is the social pillar scores for firm i in year t as provided by Refinitiv database; $SIZE_{it}$ is the natural logarithm of firm i's total assets at the end of year t; LEV_{it} is the ratio of total debt to total assets for firm i in year t; $GROWTH_{it}$ the percentage changes in sales; $LIQUIDITY_{it}$ is current assets to current liabilities for firm i in year t; $LITIGATION_{it}$ is a dummy variable of high-litigation industries, classified as 1 if the SIC codes were between 2833–2836, 3570–3577, 3600–3674, 5200–5961 and 7370–7374, otherwise 0 [40]; fixed effects are vectors for industry and year effects.

To present a more holistic view of what it entails to have a societal well-being orientation, we apply four related variables capturing different dimensions and specific characteristics of the societal well-being concerns. As outlined above, WORKFORCE, HUMANRIGHTS, PRS and COMMUNITY are categorical variables capturing whether the company is effective in term of providing employees' needs, respecting fundamental human rights conventions, producing quality goods and services, and protecting public health and respecting business ethics, respectively. In the model above, we substitute the independent variable SOCIAL with the values of WORKFORCE, HUMANRIGHTS, PRS and COMMUNITY to test the hypotheses.

4. Results and Discussion

4.1 Descriptive Analysis

Table 1 displays a descriptive analysis that includes statistical results for independent variables being among the 309 observations. The respective return on assets (ROAPCT) mean is presented as a percentage, with the highest being 72.93% and the lowest being -6.41%. The mean for the IR 4.0 variable is 0.59, indicating that over half of the companies have disclosed information regarding their industrial revolution. Additionally, the results for the societal well-being variables demonstrate that the WORKFORCE variable has a mean score of 59.13, which aligns with Ting et al.'s (2000) reported mean of 59.12 which is slightly above the midpoint of the scale. The standard deviation of 19.19 suggests that there is some variability in the scores, with some observations scoring much higher or lower than the mean. The minimum score is 6.99, while the maximum score is 97.47.

The variable WORKFORCE has a higher mean of 59.13, indicating that, on average, the companies in the sample scored higher on the well-being of their workforce compared to the other variables. The minimum score is 2.44, while the maximum score is 99.73. The variable HUMANRIGHTS has a mean of 44.78, indicating that, on average, the companies in the sample scored lower on the protection of human rights compared to the other variables. The minimum score is 15.33, while the maximum score is 97.77. Finally, the variable COMMUNITY has a mean of 46.41 with the minimum score is 1.92, while the maximum score is 98.77.

Table 1
Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ROAPCT	309	10.42	12.98	-6.41	72.93
IR4	309	0.59	0.49	0.00	1.00
SOCIAL	309	52.52	19.19	6.99	97.47
WORKFORCE	309	59.13	24.20	2.44	99.73
HUMANRIGHTS	309	44.78	22.89	15.33	97.77
COMMUNITY	309	46.41	28.28	1.92	98.77
PRS	309	49.37	26.85	2.70	99.59
SIZE	309	21.95	1.12	19.46	24.29
LEV	309	0.54	0.19	0.08	0.94
GROWTH	309	0.06	0.26	-0.54	1.31
LIQUIDITY	309	1.93	1.13	0.42	6.86
LITIGATION	309	0.08	0.25	0.00	1.00

The control variables' statistical results have revealed that firm's size has the highest mean score of 21.95, maximum of 24. 29 and minimum of 19.46. The other control variable of LEV indicates that the presence of debt is averaged at 54% of among the sample of this study although the highest could reach nearly 94%. In addition, the mean of GROWTH is 5.6 %, while the maximum is more than 100% and minimum is – 54%. LIQUIDITY and LITIGATION.

The table also reports the descriptive statistics for control variables, namely SIZE, LEV, GROWTH, LIQUIDITY, and LITIGATION. For SIZE, the statistics show a mean value of 21.95, with the smallest value observed was 19.46, while the largest was 24.29. For the LEV variable, the mean value is 0.54 ranging from 0.08 and 0.94. Regarding the GROWTH variable, the report shows an average value of 0.06 with the lowest and highest values observed were -0.54 and 1.31, respectively. With respect to the LIQUIDITY variable, the table shows an average value of 1.93 and a standard deviation of 1.13. The minimum and maximum values for this variable were 0.42 and 6.86, respectively. Finally, the LITIGATION variable, with an average value of 0.08 indicating that 8 percent of the sample comes from highly litigious industry.

4.2 Correlation Analysis

Table 2 presents the correlation analyses between the independent variables and the dependent variable. According to the pairwise correlation matrix, the SOCIAL pillar variable exhibits a strong correlation with the category variables WORKFORCE and COMMUNITY, while the other factors display weaker correlations. However, each category variable, including WORKFORCE, HUMANRIGHTS, COMMUNITY, and PRS, is included in the control variables (SIZE, LEV, GROWTH, LIQUIDITY, and LITIGATION) and examined individually in Models 2 to 4. The findings reveal that a positive correlation exists between ROAPCT and HUMANRIGHTS as well as COMMUNITY, implying that firms with a strong commitment to human rights and community tend to perform better. Conversely, negative correlations are observed between ROAPCT and SIZE, and between ROAPCT and LIQUIDITY, indicating that larger firms and those with high liquidity tend to have lower ROAPCT. The results show that the correlations among the independent variables are relatively low, hence multicollinearity is unlikely to be an issue in the multivariate regression analyses.

Table 2
Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) ROAPCT	1.000											
(2) IR4	0.050	1.000										
(3) SOCIAL	0.102	0.284*	1.000									
(4) WORKFORCE	-0.037	0.263*	0.854*	1.000								
(5) HUMANRIGHTS	0.326*	0.211*	0.505*	0.272*	1.000							
(6) COMMUNITY	0.258*	0.105	0.715*	0.357*	0.446*	1.000						
(7) PRS	-0.040	0.230*	0.686*	0.420*	0.176*	0.396*	1.000					
(8) SIZE	-0.532*	0.240*	-0.001	0.085	-0.133*	-0.214*	0.142*	1.000				
(9) LEV	-0.086	0.437*	0.049	0.062	-0.008	-0.026	0.082	0.522*	1.000			
(10) GROWTH	0.011	-0.035	-0.078	-0.071	-0.071	-0.054	-0.034	-0.005	-0.070	1.000		
(11) LIQUIDITY	-0.191*	-0.317*	-0.132	0.009	-0.163*	-0.218*	-0.143	0.154*	-0.511*	0.071	1.000	
(12) LITIGATION	-0.030	-0.080	-0.052	-0.111	0.040	0.096	-0.090	-0.044	-0.046	0.010	-0.075	1.000

*** p<0.01, ** p<0.05, * p<0.1

4.3 Multiple Regression Analysis

The results of the multiple regression analysis are displayed in Table 3. The estimation outcomes for the composite social pillar score are presented in Model 1, while Models 2 to 5 showcase the estimation outcomes for each of the individual social pillar scores, specifically WORKFORCE, HUMANRIGHTS, COMMUNITY, and PRS. Overall, the models have adjusted R2 value for all models is 79%, implying that the independent variables included in the models explain around 79% of the variance observed in the dependent variable. In other words, the models are able to account for a significant proportion of the variation in the outcome variable based on the predictors used in the analysis. This suggests that the models are reasonably good at explaining the relationship between the independent and dependent variables.

Table 3
Main Results

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable = ROAPCT				
Model	SOCIAL	WORKFORCE	HUMANRIGHTS	COMMUNITY	PRS
Intercept	99.972***	109.298***	99.462***	104.041***	105.137***
	(7.818)	(8.777)	(7.358)	(7.957)	(8.476)
IR4	2.663**	3.153***	3.376***	3.566***	2.565**
	(2.360)	(2.788)	(3.066)	(3.243)	(2.257)
SOCIAL	0.088***				
	(3.067)				
WORKFORCE		0.032*			
		(1.675)			
HUMANRIGHTS			0.047**		
			(2.144)		
COMMUNITY				0.033*	
				(1.721)	
PRS					0.056***
					(3.098)
SIZE	-4.419***	-4.819***	-4.396***	-4.605***	-4.611***
	(-7.641)	(-8.520)	(-7.221)	(-7.825)	(-8.169)
LEV	20.278***	21.221***	21.474***	21.826***	21.557***
	(6.311)	(6.537)	(6.720)	(6.834)	(6.836)
GROWTH	1.416	1.505	1.489	1.300	1.628
	(0.891)	(0.936)	(0.929)	(0.807)	(1.025)
LIQUIDITY	-1.012**	-0.970*	-0.838*	-0.750	-0.860*
	(-2.098)	(-1.963)	(-1.739)	(-1.551)	(-1.802)
LITIGATION	2.112	0.183	1.821	1.115	-0.249
	(0.440)	(0.038)	(0.372)	(0.229)	(-0.053)
Fixed effects	Included	Included	Included	Included	Included
Adj.R2	0.79	0.79	0.79	0.79	0.79
N	309	309	309	309	309
F-stat	31.919	30.996	31.247	31.018	31.945

t statistics in parentheses, * p<0.10, ** p<0.05, *** p<0.01

We further evaluate the coefficients for the variables. The positive (negative) coefficients imply that an increase (decrease) in the corresponding variables raises the chances of achieving a higher return on assets. The coefficients for IR4 are found to be positively significant in all five models, suggesting that there is a positive relationship between IR4 and ROAPCT. These results suggest that IR4 has played a crucial role in enhancing firms' performance. Therefore, the findings support the proposition that companies that disclose their IR4 components, such as robotics, artificial

intelligence, nanotechnology, quantum computing, biotechnology, the internet of things, the industrial internet of things (IIoT), decentralized consensus, fifth-generation wireless technologies (5G), 3D printing, and fully autonomous vehicle applications, tend to have superior levels of firm performance compared to those that do not reveal any such information.

The results for model 1 show that the coefficient for SOCIAL is significantly positive ($p<0.01$), indicating a positive correlation between the social pillar score and financial performance. Additionally, models 2 to 4 report positively significant coefficients at the 10% level for WORKFORCE, HUMANRIGHTS, and COMMUNITY, respectively. In model 5, PRS is positively significant at the 1% level. These findings suggest that companies that prioritize social well-being, either in total or in specific areas such as workforce, human rights, community, and product responsibility, demonstrate better firm performance.

The results also reveal that both SIZE and LIQUIDITY are significant negative variables that influence a firm's performance. In other words, as the size of the firm and its liquidity increase, its performance tends to decrease. On the other hand, the study found a significant positive relationship between LEV (i.e., leverage) and ROA. This suggests that as a firm's leverage increases, so does its performance. However, caution must be exercised in interpreting this result, as excessive leverage can also lead to financial distress and negatively impact a firm's performance in the long run. The study also examined the impact of two other variables, namely GROWTH and LITIGATION, on a firm's performance. However, the results show that the coefficients of these variables are statistically insignificant, indicating that they do not have a significant impact on a firm's performance.

5. Conclusions

The findings of this study suggest that the implementation of Industry 4.0 (IR 4.0) technologies has played a crucial role in improving the performance of firms. In other words, firms that have disclosed their adoption of IR 4.0 components, such as robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology, the Internet of Things (IoT), the Industrial Internet of Things (IIoT), decentralized consensus, fifth-generation wireless technologies (5G), 3D printing, and fully autonomous vehicle applications, are more likely to experience increased financial performance. Therefore, the study recommends that companies in Malaysia prioritize the adoption of new technologies and focus on innovation while promoting the development of human capital, as this is positively linked to high financial performance. Moreover, the government, investors, and managers should concentrate on improving societal well-being, particularly improving their employee welfare, upholding human rights, supporting local communities, and ensuring product safety and reliability, as the study shows that these factors have a positive relationship with financial performance. In conclusion, this study highlights the importance of embracing new technologies and innovation to improve the financial performance of firms. It also emphasizes the need to prioritize the well-being of employees, respect for human rights, and community development as crucial factors for achieving high financial performance. Therefore, it is vital for firms to focus on IR 4.0 technologies and societal wellbeing, to attain sustainable success in the long run.

One limitation of our study is that it only draws from data within a single country and relies exclusively on information from annual reports. To improve future research, it would be beneficial to expand to multiple countries or regions and utilize additional sources of data. This would provide a more comprehensive understanding of how the adoption of Industry 4.0 (IR 4.0) technologies and a firm's commitment to societal well-being impact performance within different environments and contexts. Furthermore, this approach would yield insights into the various factors that drive firm performance across different regions. We also encourage further investigation into the impact of

implementing Industry 4.0 (IR 4.0) technologies and prioritizing societal well-being on other firm outcomes, such as investment efficiency, market returns, and competitiveness. Additionally, our study suggests that the effect of IR 4.0 technologies and societal well-being on firm performance may be influenced by other factors, such as cultural differences, education, and nationalities. Further research could explore these potential moderating factors in greater depth. Lastly, future research could also explore the impact of other technological advancements and digital transformation beyond IR 4.0 on firm performance and societal well-being. As technology continues to rapidly evolve, it is important to understand how these advancements affect firms and society as a whole.

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References

[1] MITI. "National Policy on Industry 4.0. Ministry of International Trade and Industry, Malaysia." 2018.
[2] Yean, Tham Siew. "The Digital Free Trade Zone (DFTZ): Putting Malaysia's SMEs onto the Digital Silk Road." (2018).
[3] Vuong, Khanh Tuan, and Shaheen Mansori. "An analysis of the effects of the Fourth Industrial Revolution on Vietnamese enterprises." *Management dynamics in the knowledge economy* 9, no. 4 (2021): 447-459.
[4] Deegan, Craig. "Introduction: The legitimising effect of social and environmental disclosures–a theoretical foundation." *Accounting, auditing & accountability journal* 15, no. 3 (2002): 282-311. https://doi.org/10.1108/09513570210435852
[5] Connelly, Brian L., S. Trevis Certo, R. Duane Ireland, and Christopher R. Reutzel. "Signaling theory: A review and assessment." *Journal of management* 37, no. 1 (2011): 39-67. https://doi.org/10.1177/0149206310388419
[6] Lalic, B., Majstorovic, V., Marjanovic, U., Delić, M., & Tasic, N. (2017). The effect of industry 4.0 concepts and e-learning on manufacturing firm performance: evidence from transitional economy. In *Advances in Production Management Systems. The Path to Intelligent, Collaborative and Sustainable Manufacturing: IFIP WG 5.7 International Conference, APMS 2017, Hamburg, Germany, September 3-7, 2017, Proceedings, Part I* (pp. 298-305). Springer International Publishing. https://doi.org/10.1007/978-3-319-66923-6_35
[7] Nagy, Judit, Judit Oláh, Edina Erdei, Domián Máté, and József Popp. "The role and impact of Industry 4.0 and the internet of things on the business strategy of the value chain—the case of Hungary." *Sustainability* 10, no. 10 (2018): 3491. https://doi.org/10.3390/su10103491
[8] Sandengen, Odd Christian, Leif A. Estensen, Harald Rødseth, and Per Schjølberg. "High performance manufacturing-an innovative contribution towards industry 4.0." In *6th international workshop of advanced manufacturing and automation*, pp. 14-20. Atlantis Press, 2016. https://doi.org/10.2991/iwama-16.2016.3
[9] Tonelli, Flavio, Melissa Demartini, Andrea Loleo, and Chiara Testa. "A novel methodology for manufacturing firms value modeling and mapping to improve operational performance in the industry 4.0 era." *Procedia CIRP* 57 (2016): 122-127. https://doi.org/10.1016/j.procir.2016.11.022
[10] Ślusarczyk, Beata, Muhammad Haseeb, and Hafezali Iqbal Hussain. "Fourth industrial revolution: a way forward to attain better performance in the textile industry." *Engineering Management in Production and Services* 11, no. 2 (2019): 52-69. https://doi.org/10.2478/emj-2019-0011
[11] Adanan, Suziyanti, and Siti Zaleha Abdul Rasid. "Organizational Capabilities, Competitiveness and Business Performance of Mara Digital in Malaysia." *Journal of Advanced Research in Business and Management Studies* 24, no. 1 (2021): 17-33.
[12] Salleh, Suzila Mat, Muhammad Aizuddin Abd Aziz, Siti Fatimah Mardiah Hamzah, Noor Hafiza Mohammed, and Hani Sakina Mohamad Yusof. "Relationship Between Ease of Use, Content, and User Satisfaction on Enterprise Content Management System (ECM)." *Journal of Advanced Research in Business and Management Studies* 26, no. 1 (2022): 10-16. https://doi.org/10.37934/arbms.26.1.1016
[13] Jermsittiparsert, Kittisak, and Chanatat Boonratanakittiphumi. "The mediating role of knowledge management and the moderating role of additive manufacturing (industry 4.0) in the relationship between knowledge management

capability and firm performance: A case of KPMG Thailand." *International Journal of Innovation, Creativity and Change* 8, no. 8 (2019): 430-449.

[14] Al-Shammari, Marwan A., Soumendra Nath Banerjee, and Abdul A. Rasheed. "Corporate social responsibility and firm performance: A theory of dual responsibility." *Management Decision* 60, no. 6 (2022): 1513-1540. https://doi.org/10.1108/MD-12-2020-1584

[15] Naseem, Tahira, Faisal Shahzad, Ghazanfar Ali Asim, Ijaz Ur Rehman, and Faisal Nawaz. "Corporate social responsibility engagement and firm performance in Asia Pacific: The role of enterprise risk management." *Corporate Social Responsibility and Environmental Management* 27, no. 2 (2020): 501-513. https://doi.org/10.1002/csr.1815

[16] Eccles, N. S., and S. Viviers. "The origins and meanings of names describing investment practices that integrate a consideration of ESG issues in the academic literature." *Journal of business ethics* 104 (2011): 389-402. https://doi.org/10.1007/s10551-011-0917-7

[17] Mangalagiri, Jayasree, and Malla Praveen Bhasa. "Corporate social responsibility and firm performance: Evidence from India's national stock exchange listed companies." *International Journal of Disclosure and Governance* 19, no. 2 (2022): 144-152. https://doi.org/10.1057/s41310-021-00138-w

[18] Mai Tran, N., and M. H. Tran. "Corporate social responsibility disclosure and firm performance: Evidence from Vietnam." *Investment Management and Financial Innovations* (2022): 49-59. https://doi.org/10.21511/imfi.19(3).2022.05

[19] Khan, Inayat, Ming Jia, Xue Lei, Ruiyang Niu, Javed Khan, and Zelin Tong. "Corporate social responsibility and firm performance." *Total Quality Management & Business Excellence* (2022): 1-20.

[20] Waheed, Abdul, Shahzad Hussain, Hasan Hanif, Hamid Mahmood, and Qaisar Ali Malik. "Corporate social responsibility and firm performance: The moderation of investment horizon and corporate governance." *Cogent Business & Management* 8, no. 1 (2021): 1938349. https://doi.org/10.1080/23311975.2021.1938349

[21] Estifo, Zelalem Gebretsadik, Luo Fan, and Naveed Ahmad Faraz. "Exploring the Link Between Socially Responsible HRM and Affective Commitment of Employees in Ethiopian Context." (2019).

[22] Oh, Se Hyung, Yein Hwang, and Hwayoung Kim. "Is deep acting prevalent in socially responsible companies? The effects of CSR perception on emotional labor strategies." *Frontiers in psychology* 10 (2019): 308. https://doi.org/10.3389/fpsyg.2019.00308

[23] Rahman, Mara Ridhuan Che Abdul, Insyira Afika Ibrahim, and Dina Madinah. "Are highly unionised industries socially responsible to their employees?." *Geografia* 16, no. 2 (2020). https://doi.org/10.17576/geo-2020-1602-17

[24] Bhattacharya, Chitra Bhanu, and Sankar Sen. "Doing better at doing good: When, why, and how consumers respond to corporate social initiatives." *California management review* 47, no. 1 (2004): 9-24. https://doi.org/10.2307/41166284

[25] Ting, Irene Wei Kiong, Noor Azlinna Azizan, Rajesh Kumar Bhaskaran, and Sujit K. Sukumaran. "Corporate social performance and firm performance: Comparative study among developed and emerging market firms." *Sustainability* 12, no. 1 (2019): 26. https://doi.org/10.3390/su12010026

[26] Yu, Minna, and Ronald Zhao. "Sustainability and firm valuation: an international investigation." *International journal of accounting and information management* (2015). https://doi.org/10.1108/IJAIM-07-2014-0050

[27] Deng, Xin, Jun-koo Kang, and Buen Sin Low. "Corporate social responsibility and stakeholder value maximization: Evidence from mergers." *Journal of financial Economics* 110, no. 1 (2013): 87-109. https://doi.org/10.1016/j.jfineco.2013.04.014

[28] Dalal, Karishma K., and Nimit Thaker. "ESG and corporate financial performance: A panel study of Indian companies." *IUP Journal of Corporate Governance* 18, no. 1 (2019): 44-59.

[29] Ozigi, Obeitoh. "Social capital and financial performance of small and medium scale enterprises." *Journal of Advanced Research in Business and Management Studies* 10, no. 1 (2018): 18-27.

[30] Hatane, Saarce Elsye. "Employee satisfaction and performance as intervening variables of learning organization on financial performance." *Procedia-Social and Behavioral Sciences* 211 (2015): 619-628. https://doi.org/10.1016/j.sbspro.2015.11.081

[31] Callan, Scott J., and Janet M. Thomas. "Corporate financial performance and corporate social performance: an update and reinvestigation." *Corporate social responsibility and environmental management* 16, no. 2 (2009): 61-78. https://doi.org/10.1002/csr.182

[32] Busch, Timo, and Gunnar Friede. "The robustness of the corporate social and financial performance relation: A second-order meta-analysis." *Corporate Social Responsibility and Environmental Management* 25, no. 4 (2018): 583-608. https://doi.org/10.1002/csr.1480

[33] Berman, Shawn L., Andrew C. Wicks, Suresh Kotha, and Thomas M. Jones. "Does stakeholder orientation matter? The relationship between stakeholder management models and firm financial performance." *Academy of Management journal* 42, no. 5 (1999): 488-506. https://doi.org/10.2307/256972

[34] Pekovic, Sanja, and Sebastian Vogt. "The fit between corporate social responsibility and corporate governance: the impact on a firm's financial performance." *Review of Managerial Science* 15 (2021): 1095-1125. https://doi.org/10.1007/s11846-020-00389-x

[35] Ioannou, Ioannis, and George Serafeim. *What drives corporate social performance?: International evidence from social, environmental and governance sources*. Cambridge: Harvard Business School, 2010.

[36] Cheng, Beiting, Ioannis Ioannou, and George Serafeim. "Corporate social responsibility and access to finance." *Strategic management journal* 35, no. 1 (2014): 1-23. https://doi.org/10.1002/smj.2131

[37] Ismail, Wan Adibah Wan, and Khairul Anuar Kamarudin. "Deceptive versus informative income smoothing: Evidence from audit committee attributes." *ICOPS2017 eProceedings* (2017): 781-789.

[38] Kamarudin, Khairul Anuar, Wan Adibah Wan Ismail, and Airul Aezza Kamaruzzaman. "Board members diversity and financial statements fraud: Malaysian evidence." In *State-of-the-Art Theories and Empirical Evidence: Selected Papers from the 6th International Conference on Governance, Fraud, Ethics, and Social Responsibility*, pp. 165-183. Springer Singapore, 2018. https://doi.org/10.1007/978-981-10-6926-0_10

[39] Ismail, Wan Adibah Wan, and Khairul Anuar Kamarudin. "Family firms and audit risks: The role of audit committee financial expertise." In *2012 IEEE Symposium on Business, Engineering and Industrial Applications*, pp. 263-267. IEEE, 2012. https://doi.org/10.1109/ISBEIA.2012.6422883

[40] Ashbaugh, Hollis, and Ryan LaFond. "Reporting incentives and the quality of non-US firms working capital accruals." *Working paper* (2003).