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How much is global business sectors contributing to sustainable development goals?

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ABSTRACT

While the 17 United Nations Sustainable Development Goals (SDGs) have explicitly called on businesses to contribute, little is known to what extent have the business sectors engaged with the SDGs. Here we benchmarked the engagement of the Fortune Global Top 500 corporations with the SDGs based on publicly available information screened between November 1, 2019, and February 15, 2020. The results revealed that 304 of the 500 corporations had presented relevant content on their websites. However, 32.6% of the corporations tend to match their usual business practices with relevant SDGs instead of implementing new initiatives. Only 22.8% of the corporations developed specific actions or strategies for specific SDGs, and only 0.2% developed methods and tools to evaluate progress. European-headquartered corporations are leading the way to engage with the SDGs, whereas U.S.- and China-headquartered ones fall short. The SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action) are the most popular SDGs among these corporations. At the same time, SDG 2 (Zero Hunger) and SDG 14 (Life below Water) received the slightest interest. The level of engagement is uneven across various business sectors, with the corporations in the Information & Technology sector have largely engaged with the SDGs. In contrast, the Health Care sector has shown the slightest interest in the SDGs. Our results call for leading corporations in these sectors for continuous and enhanced efforts to help accelerate the global process towards the SDGs. Governments could provocatively encourage and regulate business sectors to engage with the SDGs and disclose uniform data to benchmark the progress towards a sustainable future.

1. Introduction

In 2015, all United Nations Member States adopted the 2030 Agenda for Sustainable Development which provides a shared blueprint for peace and prosperity for people and the planet, now and into the future (United Nations (a), 2020; STS&P, 2020). At its heart are the 17 Sustainable Development Goals (SDGs), aiming to address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace, and justice (United Nations (a), 2020). Similar to the Millennium Development Goals, the SDGs aim to mobilize resources from the Member States, but the SDGs go further to explicitly call on businesses to contribute with other stakeholders (SDG Compass Guide, 2020; Malay, 2021).

Many countries and cities have developed their plan to implement SDGs. For instance, China released its first national plan for implementing SDGs back in 2016, and it has integrated the sustainable de-

velopment goals into the 14th five-year plan for the country in 2020 (The State Council PRC, 2020). The Netherlands intends to make the SDGs the leading policy framework for the country in the next 15 years (United Nations (b), 2020). In terms of implementing SDGs at the city level, New York City is the pioneer city that submitted the city-level SDG implementation report (NYC, 2021). Helsinki followed the pioneer and submitted the SDG implementation report in 2018 (Helsinki, 2021). The reports at the country and city level mainly illustrate the edges and plans of cities to achieve the SDGs from the perspective of governments. Usually, they lack strategies and implementation processes (Rodriguez et al., 2018). Frameworks and action pathways have been developed for the sustainable transformation of cities, and systematic methods were also developed for assessing Spatio-temporal progress towards achieving the SDGs at the national and sub-national level (Elmqvist et al., 2019; Rosenzweig & Solecki, 2018; Xu et al., 2020).

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Except to implement SDGs at the national and subnational level, the actions from business sectors are of vital importance in achieving the SDGs (Pedersen, 2018; Salvia et al., 2019; Topple et al., 2017). According to the World Business Council for Sustainable Development study, the business sectors drive 84% of GDP and 90% of employment opportunities in developing countries and play a vital role in the pursuit of technological innovation (World Business Council for Sustainable Development, 2020). Therefore, it is essential to call for the effort from business sectors to align their business value with the SDGs at all stages of business development.

Although corporations are profit-driven, with the increasing pressure from policy, market competition, customers, and the general public, among others, business sectors have started to engage with the SDGs framework. For instance, Danone, the multinational food and beverage company, released that it is fully committed to the SDGs and has aligned its 2030 goals. According to their annual report, it tends to share sustainable value efficiently and responsibly and encourages healthier and more sustainable eating behaviors (Danone, 2021). JD, an e-commerce company, claimed that it fully integrated SDGs into its corporate management practices. The company promotes the popularization of sustainable consumption concepts and green living while continuously improving the consumer experience and helping the sustainable development of upstream manufacturing by responsible procurement and supply chain management (JD, 2021). A study showed that business aligning with sustainability goals could result in 'win-win' situations for economic progress and sustainable development (Burritt and Schaltegger, 2010). Companies can respond to the SDGs by technology innovation, such as the replacement of traditional energy sources by renewable energy sources and replacing conventional manufacturing and processing products by using information and communication technology and other technical solutions (S&P Global, 2021; Zhu et al., 2019). Simultaneously, contributing to the SDGs can enable existing corporations to innovate their business processes, capture new market opportunities, attract investment, and enhance social reputation (de Villiers et al., 2021). It is estimated that the SDGs can unlock the US \$12 trillion in business opportunities by 2030 (United Nations (a), 2020).

Various studies tend to explore the factors that can affect the corporation's implementation of the SDGs (Martins et al., 2020; Mutale et al., 2019; Vildasen, 2018). An exploratory survey conducted across 81 European and North American companies among the Financial Times Global 500 revealed that multinational corporations engage more with SDG targets than others (van Zanten and van Tulder, 2018). A recent study that interviewed 58 respondents from 16 sample firms located in the Philippines, Indonesia, Thailand, and Vietnam showed that multinational enterprises would set particular SDGs during establishing, expanding, or subsidiary operations in these countries, and the non-governmental organizations and the local community could influence their prioritization in selecting the focused SDGs (Ike et al., 2019). Another study revealed that several multinational enterprises operating their manufacturing industry in Indonesia claimed that their initial engagement with the SDGs was directly due to regulatory compliance, and only mandatory targets were considered. The influence from headquarters directs their decision to consider sustainability issues (Borgert et al., 2018). These case studies give a peek at the reasons that drive the engagement of business sectors to the SDGs in specific industries and countries. In terms of the progress made toward the SDGs in business sectors, a conceptual framework was proposed in a recent study and suggested that the internet-of-things and blockchain technology could help to measure the effort and progress of business sectors toward achieving the SDGs (de Villiers et al., 2021). Another recent study analyzed that 23% of the 2000 largest stock listed corporations mentioned the SDGs in their annual reports (Van der Waal and Thijssens, 2020). However, mentioning the SDGs in their annual report doesn't necessarily mean they are effectively engaged with them or have taken any actions to address the SDGs in their operation.

Our understanding of the status and progress of embracing the SDGs in business sectors is limited. While many corporations mentioned the

SDGs in their report, it lacks evaluation and tracking tools to benchmark the current status and actions in implementing the SDGs in the business sectors. Business sectors hold a significant influence on economic and social stability. For instance, The Fortune 500 corporations generated \$32.7 trillion in revenue and \$2.15 trillion in profit, and 69.3 million jobs in 35 countries across 56 industries worldwide in 2018 (Fortune, 2020). It is essential to assess to what extent the business sectors have engaged with the SDGs considering their roles in economic and social importance. To what extent would the business industry stretch the effort for sustainable development is critical for policymakers to better plan their strategy and policies to encourage and regulate companies towards achieving SDGs.

To unveil the status of the SDGs adoption in business sectors and identify potential factors affecting the adoption, we reviewed the SDGs relevant reports of the 500 corporations listed by the Fortune 500 worldwide. We conducted a quantitative analysis to map the SDGs footprints in 2019. The level of engagement per corporation is benchmarked towards the SDGs framework and individual SDGs. We aim to answer the following questions: First, how many Fortune 500 corporations have engaged with the SDGs framework, to what extent have they engaged with individual SDGs and their priorities? Second, how does the geographic distribution of companies affect their engagement with the SDGs? Third, how do the engagement with the SDGs and the prioritized SDGs differ across industries? Fourth, what is the role of revenue in the engagement with the SDGs framework?

2. Methods

To answer these questions, we conducted a quantitative analysis to map the SDGs footprints across the Fortune 500 corporations worldwide ranked in the Fortune Global 500 in 2019. The Fortune 500 corporations are chosen for this study because of their critical role in the global economy, with \$32.7 trillion in revenue and \$2.15 trillion in profit and \$69.3 million jobs in 35 countries across 56 industries worldwide in 2018 (Fortune, 2020). They are the leaders in the business sectors, and their engagement with the SDGs can make a difference to society. As many of them are international companies, the prominent locations of these companies are chosen according to the sites of their headquarters. These corporations were distributed in 35 countries and regions, covering nine business sectors and 56 industries according to the Fortune 500.

To map the footprints of the SDGs at the corporate level, firstly, we identified which corporations have mentioned the SDGs on their official websites by using the following terms: "UN Sustainable Development Goals," "Sustainable Development Goals," "UNSDGs," and "SDGs." The information was collected from the online pages and the latest annual report, Corporate social responsibility report, and other online accessible reports, if any, that were displayed on their official website. The data sources are listed in Supplementary Information 1. If multiple reports are displayed on a corporation's official website with SDGs, the latest report or the report with more detailed SDGs prevails. The search was conducted manually from November 1st, 2019, to February 15th, 2020. The critical information regarding the SDGs from their websites and relative reports was extracted and categorized into six categories (0-5):

- **Unknown (depth = 0):** cannot confirm any SDGs footprints because of inaccessible websites;
- **Uninvolved (depth = 1):** cannot find any information related to SDGs on official websites;
- **Preliminary (depth = 2):** mentioned the SDGs briefly without any further information;
- **Elementary (depth = 3):** Matched their existing strategies and projects with the SDGs framework or individual SDG;
- **Intermediate (depth = 4):** planned strategies or conducted actions specially for the SDGs framework and individual SDG;

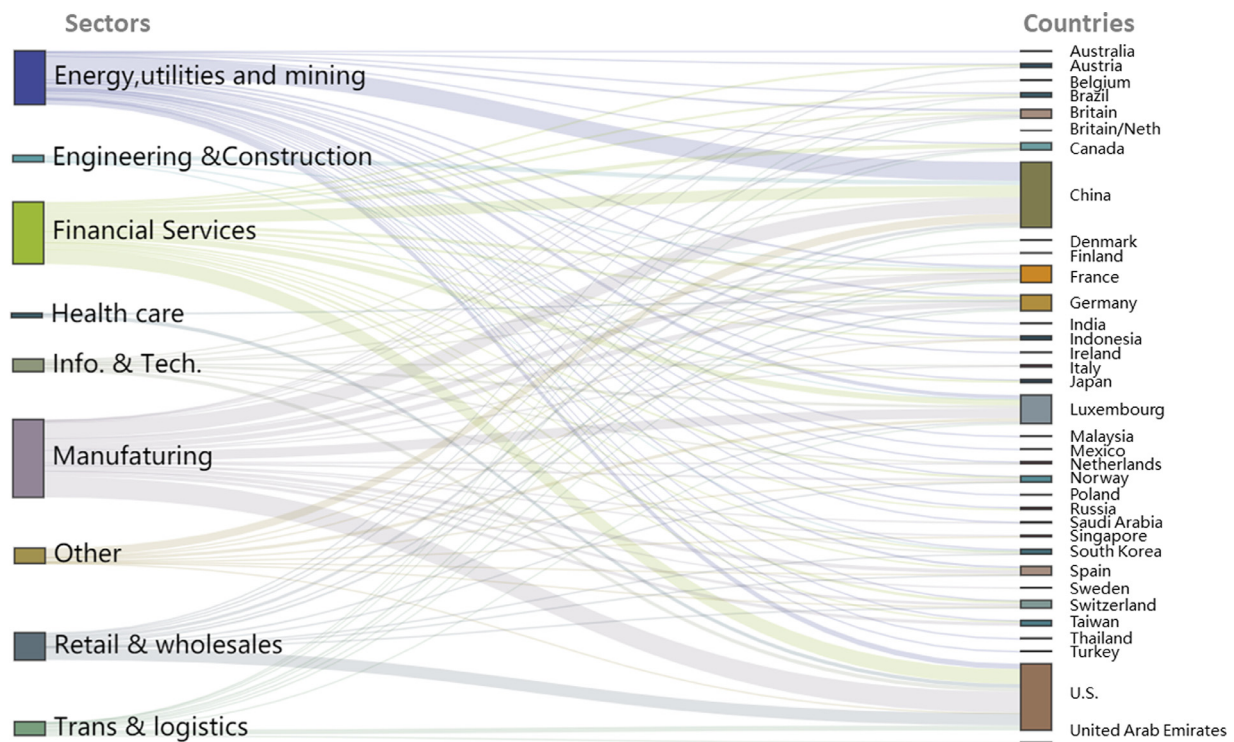


Fig. 1. The distribution of the nine business sectors across countries.

- **Advanced (depth = 5):** developed methods or tools that specifically help assess their impact against relevant SDGs.

The engagement rate is defined as the percentage of corporations that are expressed their interests and participated in the SDGs framework, or to any individual SDG, at the global, regional, country, business sector, and individual industry levels, which are calculated according to the Eq. 1.

$$\text{Engagement Rate} = \frac{\sum_{i=2}^5 n_i}{\sum_{i=0}^5 n_i} \quad (1)$$

in which n represent the number of corporations in each category, i represents the depth of that category.

The engagement depth is defined as the weighted average of engagement levels towards the SDGs framework across countries and industries. The potential correlation between the average engagement depth and revenues is analyzed across countries and industries. The engagement depth per country and per industry are calculated according to Eq. 2 and plotted together with the corresponding average revenue with standard deviations.

$$\text{Engagement Depth} = \frac{\sum_{i=0}^5 n_i * i}{\sum_{i=0}^5 n_i} \quad (2)$$

in which n represent the number of corporations in each category per country or per industry, i represents the depth of that category. The correlation between the revenue and the corresponding engagement depth with the SDGs framework is explored by linear regression.

3. Results

3.1. Characterization and distribution of the Fortune 500

The Fortune 500 are distributed in 56 industries, which can be categorized into nine business sectors based on the main activities of these corporations. The relationship between the individual industry and the

nine sectors is displayed in Supplementary Information 2. Fig. 1 shows the relationship between the nine business sectors and the corporation's location. The headquarters of the Fortune 500 are distributed across 35 countries and regions, of which 70.4% of them are distributed among the U.S., China, Japan, France, and Germany. Both U.S. and China have more than 110 top corporations. There is no clear trend observed between the distribution of the corporations and their sector categories.

3.2. Engagement towards the SDGs framework

3.2.1. Global level

The percentage of the Fortune 500 corporations engaged with the SDGs framework is encouraging, but many engagements are superficial.

We found that the SDGs framework has been adopted by the majority of the Fortune 500 (Fig. 2a). 304 out of the 500 corporations have engaged with the SDGs framework and presented relative content on their websites. Although 32.6% of corporations offer their sustainable development strategies or projects on their website, they have just matched their usual business against the SDGs instead of planning a new strategy. 22.8% of corporations developed specific actions or strategies for individual SDG. However, the adoption of the SDGs framework is still in its infancy. There are still 39.0% of the Fortune 500 corporations that didn't present any SDG context online. 5.2% of the Fortune 500 corporations have just mentioned the SDGs briefly without further information, implying their engagement with the SDGs framework may not have been adopted in these corporations. 32.6% of companies with elementary engagement with the SDGs framework have just matched their project and strategies against the SDGs framework. These companies are still doing business as usual and have not developed new strategies or new projects specifically considering the SDGs framework. About 22.8% of the Fortune 500 corporations have engaged with the SDGs framework. Only 0.2% of the corporations developed methods and tools to assess and evaluate the progress of their actions towards relevant SDGs.

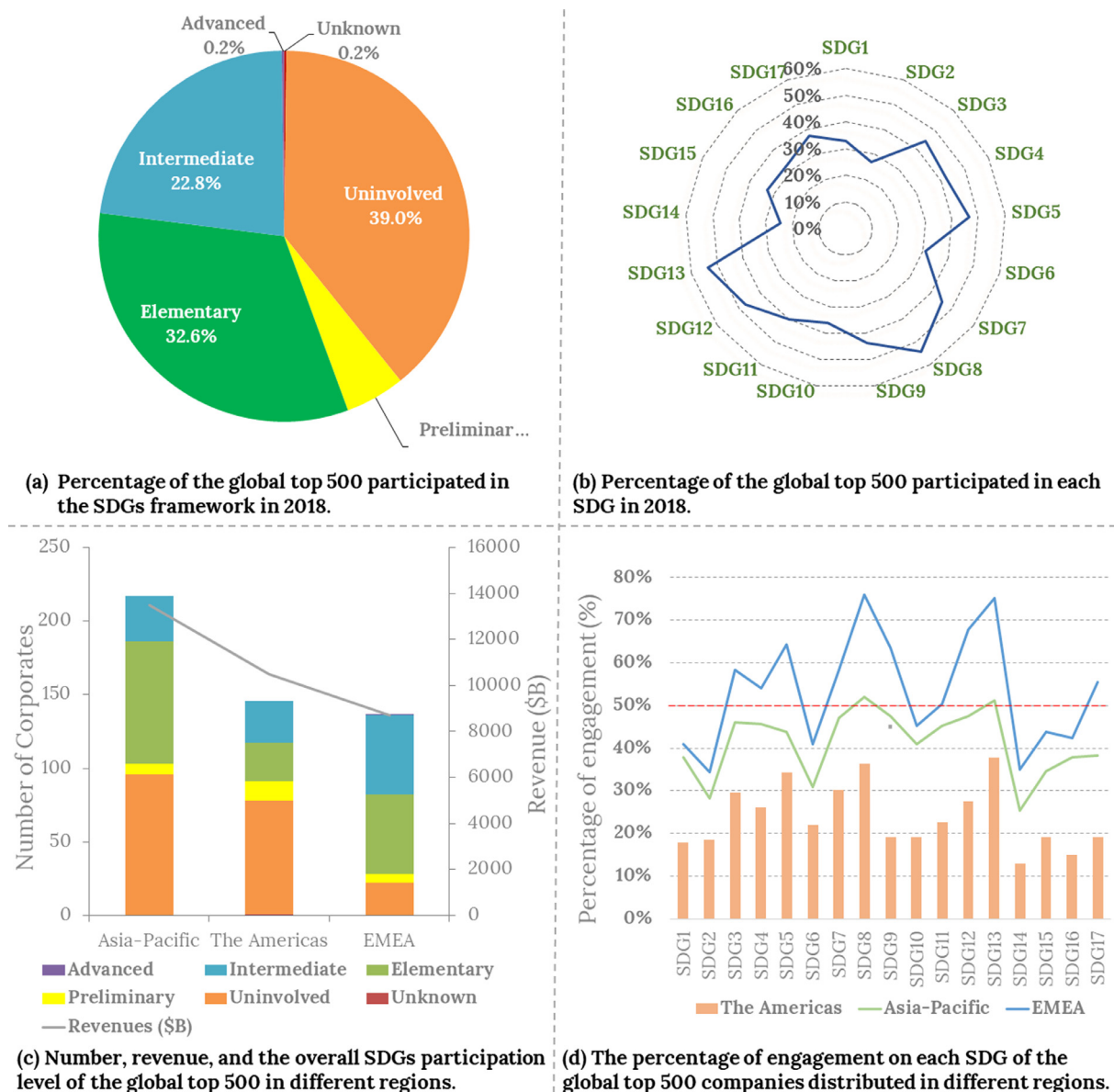


Fig. 2. (a) Percentage of the Fortune 500 corporations participating in the SDGs framework by the 15th of February 2019. (b) Percentage of the Fortune 500 corporations participated in each SDG by the 15th of February 2019. (c) Number, revenue, and the overall SDGs participation level of the Fortune 500 corporations in different regions (the countries included in each area can be found in Supplementary Information 3). (d) The percentage of engagement on each SDG of the Fortune 500 corporations is distributed in different regions.

SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action) are the most popular SDGs among the Fortune 500.

In terms of the engagement with individual SDG, more than 50% of the Fortune 500 corporations acted toward SDG 8 (Decent Work and Economic Growth) and SDG13 (Climate Action). Meanwhile, SDG 12 (Responsible Consumption and Production), SDG 5 (Gender Equality), and SDG 7 (Affordable and Clean Energy) received attention from 47.2%, 46.6%, and 45.2% of the Fortune 500 corporations, respectively (Fig. 2b). SDG 14 (Life below Water), SDG 2 (Zero Hunger), and SDG 6 (Water and Sanitation) received the lowest attention among the Fortune 500 corporations (approximately 30%). The difference in engagement rate across the seventeen SDGs reveals the business industries are either interested in the high-profile goals, such as climate action and gender equality, to improve their public image or the goals that closely align with their business interests, such as decent work and economic growth, responsible consumption and production, or affordable and clean en-

ergy. The goals that are not directly related to business returns are less popular, like Zero Hunger and Life Below Water.

3.2.2. Continental level

Europe, Middle East & Africa (EMEA) region is leading the SDG engagement compared to Asia-Pacific and the Americas. Although the total revenue of the Fortune 500 corporations distributed in the EMEA region is the lowest compared to the corporations located in the Americas and Asia-Pacific, they are leading the way towards engaging all the SDGs (Fig. 2c&d). More than 50% of the EMEA-headquartered Fortune 500 corporations have engaged with the SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 17 (Part-

nerships for the Goals). Specifically, SDG 13 (Climate Action) and SDG 8 (Decent Work and Economic Growth) received the highest engagement of the EMEA-headquartered Fortune 500 corporations (approximately 75%).

The Asia-Pacific region has the highest number of Fortune 500 corporations and the highest total revenue among the three regions (217/500). However, only 54% of corporations have engaged with the SDGs. Like the EMEA-headquartered top corporations, the SDGs that received the highest engagements are SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action) among the Asia-Pacific headquartered Fortune 500 corporations. Except the SDG 8 and 13, none of the other SDGs received more than 50% engagement from the Fortune 500 in the Asia-Pacific region.

Although the total revenue and the number of the Fortune 500 corporations located in the Americas are slightly higher than those in the EMEA region, the engagement rate of the Americas-headquartered Fortune 500 with the SDGs framework is the lowest among the three regions. Results showed that none of the SDGs received more than 50% engagement from the Americas-headquartered Fortune 500 corporations. Interestingly, the SDGs received the highest attention from the Americas-headquartered Fortune 500 corporations are consistent with the EMEA and the Asia-Pacific region, i.e., the SDG 8 (Decent Work and Economic Growth, 36.3%) and SDG 13 (Climate Action, 37.7%).

3.2.3. National level

The Japanese, French, German, and Britain corporations are more advanced in the SDGs adoption compared to the U.S.- and China-headquartered corporations. Only 3.8%, 22.6%, 24.1%, and 6.3% of Japanese, French, German and British companies didn't display SDGs in context online, respectively (Fig. 3a). Japan has the best performance among the five top countries, in which only 11.5% of Japan-headquartered corporations have no or preliminary engagement with the SDGs. Most Japan-headquartered corporations (88.5%) displayed their sustainable development strategies or projects with relevant SDGs (elementary level, 75.0%) or had specific actions or strategies for individual SDG (intermediate level, 13.5%). 3.4% of Germany-headquartered corporations developed tools or methods to benchmark their performance against each SDG (advanced level), which is the highest across all the countries. For countries that have less than twenty Fortune 500, the UK, Switzerland, the Netherlands, Spain, Australia, and Italy showed an impressive engagement with the SDGs.

In terms of the average engagement depth, the Fortune 500 located in the UK, Netherlands, Finland, Sweden, Ireland, and Spain displayed the highest engagement level towards the SDGs framework (Fig. 3b). These companies have not only revealed the SDGs related content on their website or their annual report, but the majority of them have also developed strategies or conducted actions specially for the SDGs framework and individual SDG. Although Japanese companies have the highest engagement rate towards the SDGs framework, the average engagement depths are not as advanced as European countries.

The U.S. and China have the most significant number of Fortune 500 corporations, while their engagement with the overall SDGs framework is pending improvement. Both U.S. and China have more than 110 top corporations, but their engagements with SDGs are inadequate (Fig. 3a). Incredibly, 57.9% of U.S.-headquartered Fortune 500 didn't display any SDGs relative context online, 8.3% and 15.7% of them presented elementary and intermediate engagement with the SDGs. Only 17.4% and 0.8% of U.S.-headquartered Fortune 500 showed intermediate and advanced SDG engagement. The engagement with the SDGs among the China-based Fortune 500 were even worse; more than 70% of the Fortune 500 based in China haven't engaged with the SDGs yet in 2018, and 22.7% of them only presented elementary engagement with the SDGs, which leave only 6.7% showed intermediate engagement with the SDGs. The average engagement depth of corporations based in the U.S. and

China are ranked at the fourth and the third from last (Fig. 3b), implying most companies based in the two countries have not taken practical actions towards the SDGs.

3.3. The unequal engaging rate among individual SDG across countries

Fig. 3a reveals the detailed engagement rate of the Fortune 500 on individual SDGs across countries. Results showed that SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action) are the most popular goals, especially among the European-headquartered countries. However, only 33.1% and 28.6% of the U.S.- headquartered and China-headquartered Fortune 500 corporations have acted toward the SDG 13 (Climate Action), which is their highest engaging rate among the seventeen SDGs in both countries. The engagement rates for the SDG 8 are only 30.6% and 28.6% among the U.S.- headquartered and China-headquartered Fortune 500 corporations, respectively. Considering many Fortune 500 corporations are based in the U.S. and China, such a low engaging rate implies both countries haven't implemented proper guidelines or policies for businesses to participate in the SDGs framework, or the awareness of SDGs framework in both countries are still pending improvement.

The SDG 2 (Zero Hunger) and the SDG 14 (Life below Water) received the lowest attention from the Fortune 500 across all countries. At the same time, the engagement with SDG 6 (Clean Water and Sanitation), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduce Inequalities), and SDG 11 (Sustainable Cities and Communities) varies significantly across countries. These variations align with the differences in industry structure, geological locations, and culture across nations. It is interesting to find the Fortune 500 corporations based in Canada, the Netherlands, and Australia have pretty low engagement rates on SDG 6 (Water and Sanitation) and SDG 14 (Life below Water).

3.3.1. Sector level

To check which sectors are more advanced in the implementation of SDGs and on which individual SDGs, help companies to benchmark their performance among the companies under the same sectors, and guide the policymakers to plan better their strategies in involving more companies to implement the SDGs we plotted the sector's performance in Fig. 4.

The Information & Technology sector has the highest engagement rate to the overall SDGs framework across all industries. When looking at the nine sectors, although the manufacturing sector has the largest share in the Fortune 500 corporations, Information & Technology sector has the highest engagement rate to the overall SDGs framework across all sectors, with 69.6% to the SDG 4 (Quality Education) and SDG 8 (Decent Work and Economic Growth), and 73.9% to SDG 13 (Climate Action) (Fig. 4). It was followed by the Manufacturing and Energy sector, with several engagement rates are higher than 50% to the individual SDG. Less than half of the top corporations in the Retail and wholesale sector, the Transportation and logistics sector, and the Engineering and Constructions sector are committed to the SDGs framework. The highest engagement made by the Fortune 500 corporations in the sector of Retail and wholesale and the Transportation and logistics sector is on the SDG 8 (Decent Work and Economic Growth), which is 40%. These sectors don't pay much attention to goals like life below water or ending poverty and hunger.

The Health Care sector has the lowest engagement rate with SDGs among all the sectors analyzed. Only 37.5% of the corporations in the Health care sector have engaged with the SDGs focusing on SDG 3 (Good Health and Well-Being) and SDG 8 (Decent Work and Economic Growth). Health care corporations among the Fortune 500 has zero engagement towards the SDG 1 (No Poverty), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 14 (Life below Water), SDG 16 (Peace, Justice and Strong

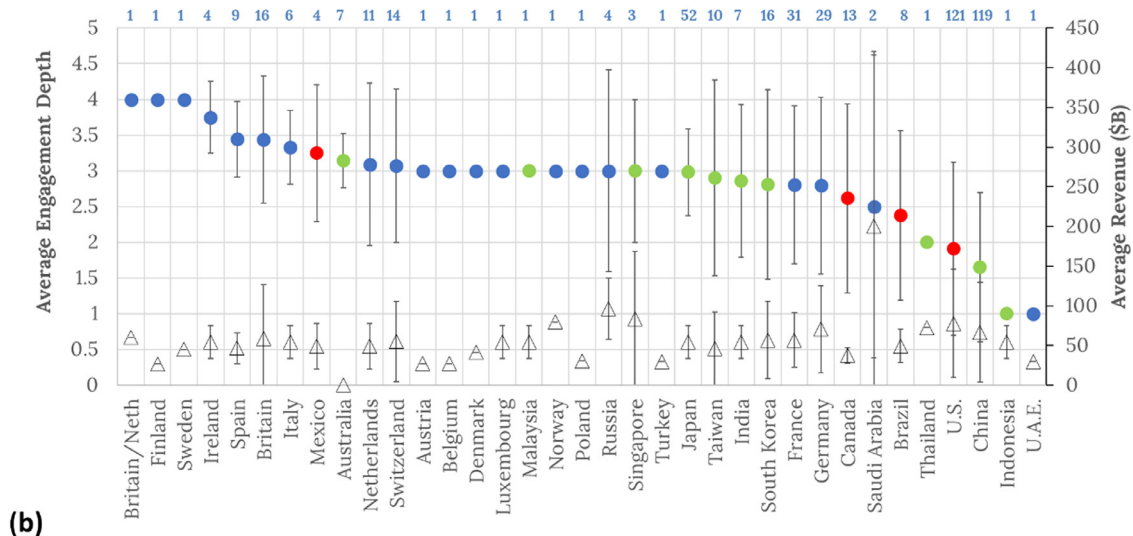
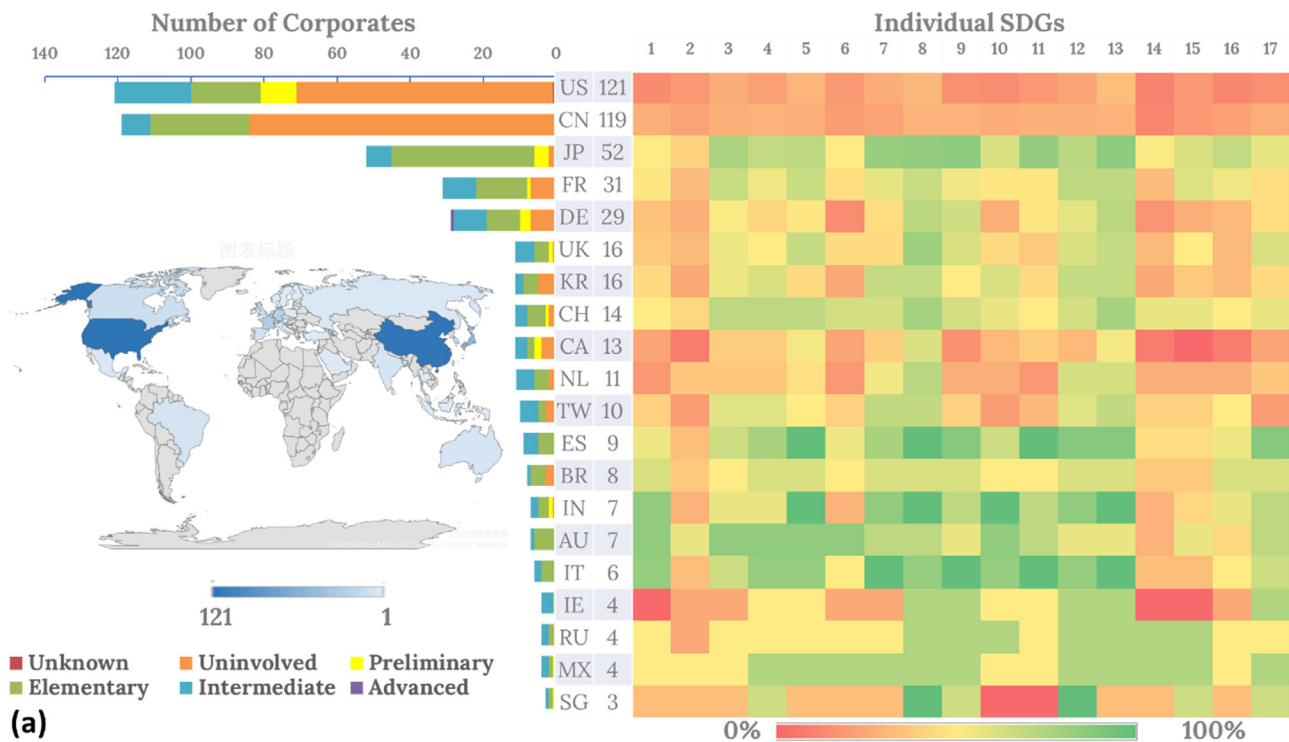


Fig. 3. (a) The number of the Fortune 500 corporations across countries and regions and their engaging rate with individual SDG across countries and regions. Information regarding the SDGs engagement in more countries, please see Supplementary Information 4. (b) The average engagement depth (dots) to the SDGs framework across countries and regions with standard deviation (the EMEA region is marked in blue color, The Americas is marked in red color, the Asia-Pacific region is marked in green color), plotted together with average revenue (triangle) in each country with standard deviation. The number marked in blue on the top of (b) represents the number of the Fortune 500 in each country. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Institutions) and the SDG 17 (Partnerships for the Goals). These findings revealed that the health care industry is lagging in adopting the SDGs framework compared to other industries.

3.3.2. Industry-level

The engagement depth varies significantly across industries. The Food industry, health care specialized in pharma & other services, medical products & Equipment, and tobacco companies showed the most profound engagement toward the SDGs framework. All companies planned strategies towards the SDGs framework (Fig. 5). However,

the total number of Fortune 500 in these industries is relatively low. Meanwhile, wholesalers specialized in food & grocery and electronic & office

Equipment, companies in textiles industries, insurance companies specialized in property and causality (mutual), diversified financials, and Apparel industries are not motivated to take any actions towards the SDGs framework. The engagement depth varies significantly within most industries, implying there is no common standard or common sense toward understanding the value of adopting the SDGs framework in these industries.



Fig. 4. Engagement with the SDGs at the nine sectors: (a) on the overall framework and (b) on individual SDG.

Engagement with the individual SDG is linked with the intrinsic characters of each industry (Supplementary Information 5 & 6). In corresponding to their role to the society and their impact on the environment, petroleum refining companies are leading the engagement with all the SDGs other than the SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life below Water), SDG 15 (Life on Land), SDG 16 (Peace, Justice and Strong Institutions), and SDG 17 (Partnerships for the Goals). Similarly, Banks (Commercial and Savings) are leading the engagement with SDG 1 (No Poverty), SDG 4 (Quality Education), SDG 5 (Gender Equality), and SDG 10 (Reduce Inequalities), which reflects the role of banks to the society. Motor Vehicles and Parts are leading the SDG commitments relevant to their responsibility to the community as well, i.e., the SDG 3 (Good Health and Well-being), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 11 (Sustainable Cities and Communities).

There is no clear trend between the SDGs engagement and the difference in industry distribution across countries. Although the number of Fortune 500 corporations distributed in the U.S. and China are close (121 in U.S. and 119 in China), the industrial structure in the U.S. is more diverse among the Fortune 500 corporations. The Fortune 500 corporations are spread out in 47 industries, whereas the top corporations are only distributed across 29 industries in China. Japan has 52 corporations among the Fortune 500 corporations across 19 industries. France and Germany have 31 and 29 Fortune 500 corporations, respectively, distributed among 21 industries in both countries. There is no clear link between the engagement with the SDGs and the industry structure across countries, implying the difference in industry distribution doesn't play an essential role in the SDGs engagement.

There is no clear trend observed between the ranking/revenue of corporations and their engagement with the SDGs (Supplementary Information 7). The correlation between the revenue and the engagement level of the 500 corporations is 0.040, implying the engagement with the SDGs is barely associated with their revenue.

4. Discussion

The 17 Sustainable Development Goals are the essential targets to achieving the 2030 Agenda for sustainable development. The Goals are set to help countries and cities identify their challenges, bench-

mark their progress, and better plan their strategies to achieve the 2030 agenda. Many efforts have been made to create measurable, comparable, and accessible methods to track the progress of the SDGs at different levels. For instance, the United Nations built the SDG Progress Chart 2020 to evaluate global progress (United Nations (c), 2021). The United Nations global compact system has developed an evaluation and participation system to assess the engagement from business sectors. Yet, only 28 companies in their system have reported on the SDGs (UNGlobalcompact, 2020). The Times Higher Education Impact Rankings has also introduced measures to benchmark the performance of universities against the SDGs (The Times Higher Education, 2021). A global-scale machine learning-based human footprint index was built to evaluate the progress of 43 countries on achieving SDG15 by analyzing the satellite images (Keys et al., 2021). A composite SDG Index classifies the 17 SDGs into four directions, i.e., society, economy, environment, and means of implementation and cooperation was developed to reveal the performance of achieving SDGs across 15 countries (Huan et al., 2021).

This study mapped in detail the engagement rate of the Fortune 500 corporations with the overall SDGs framework and their in-depth engagement with individual SDG for the first time. Yet there are many Fortune 500 corporations across industries that fall short of engaging the SDGs framework. In addition, many corporations tend to match their usual business route towards the relative SDGs instead of planning new strategies for the SDGs. Their disclosures of engagement with the SDGs essentially add value to their branding (Lu et al., 2020). The primary motivations for specific industries could mainly be due to the expected financial benefits (Naidoo & Gasparatos, 2018). Less than 1% of corporations developed tools and methods to assess and evaluate the progress of their action against relevant SDGs. These findings express concerns over the progress of adopting the SDGs framework in business sectors. Meanwhile, the low uptake of the SDGs framework across industries may indicate that it needs to be better structured to guide the business and lead the transition towards a more sustainable society.

The present study revealed that the location of headquarters plays a vital role in affecting the SDGs engagement in the business sectors. European-headquartered corporations are leading the way, whereas the Global 500 corporations located in the U.S. and China fall short on the engagement rate and engagement level with the SDGs. Such differences may associate with regional and country policies. A previous study showed that government regulations significantly impact the environ-

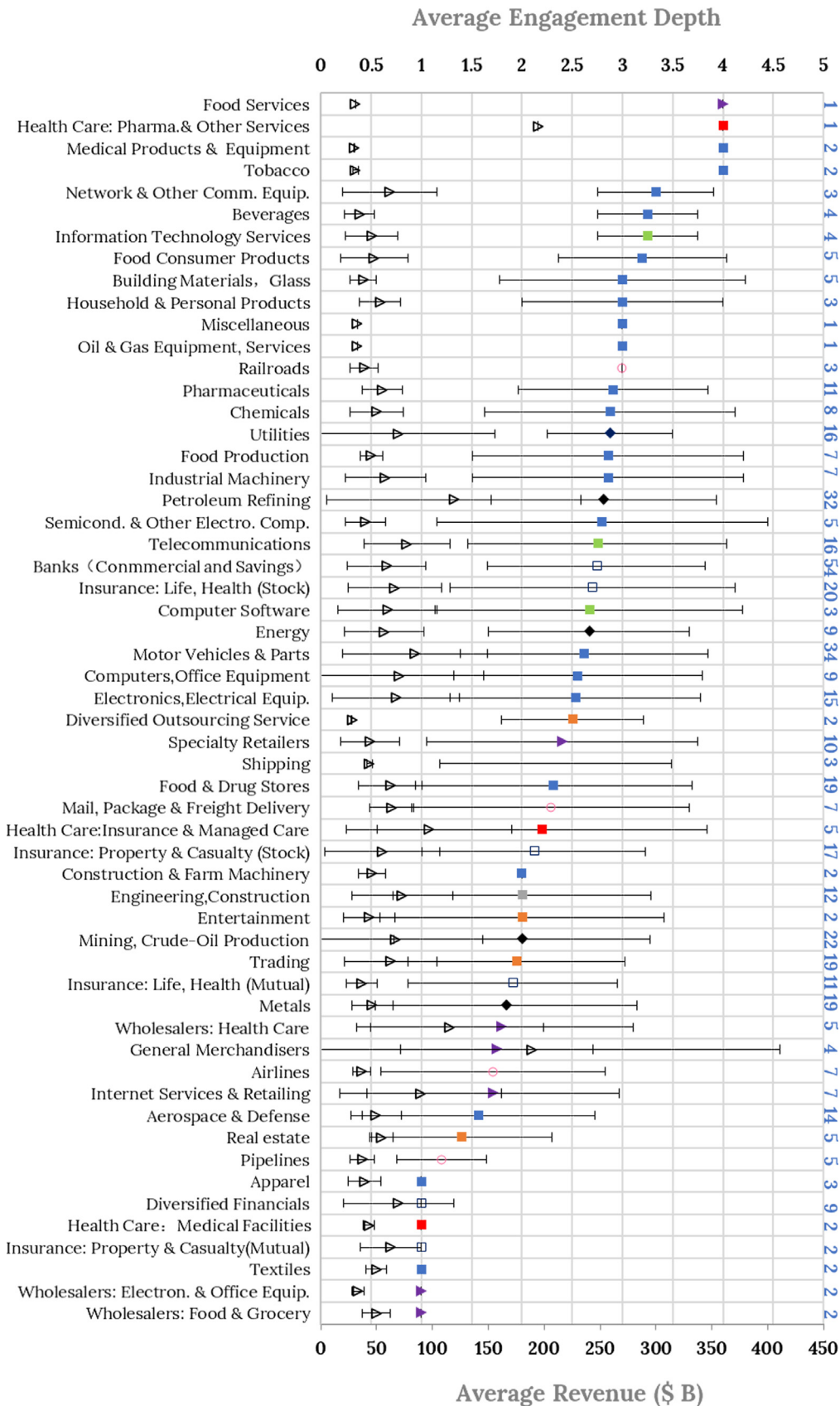


Fig. 5. The average engagement depth to the SDGs across the individual industry with standard deviation (colors represent the extensive industry categorization, the purple triangle represents the retail & wholesale industry, the red rectangle represents the health care industry, the blue rectangle represents the manufacturing industry, green rectangle represents the information transmission, software, and information industry, the open blue rectangle represents the financial services industry, red circle represents the transport & logistics industry, the black diamond represents the energy, utilities, and mining industry, the grey rectangle represents the engineering & construction industry, the orange rectangle represents the miscellaneous industry), plotted together with average revenue (open triangle) in each industry with standard deviation. The number marked in blue on the right edge represents the number of the Fortune 500 in each industry. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

mental performance of heavily polluting industries (Söderholm et al., 2019). Strict ecological regulations positively influence multinational enterprises' commitment to the environment (Lin et al., 2019). Countries need to align visions further and share experiences to promote the SDGs among business sectors. On the other hand, multinationals are as global citizens to bring SDG-related business practices to other countries through their worldwide outreach and help set higher expectations and standards for local businesses. For example, Siemens developed a methodology to evaluate their contribution to achieving the SDGs in different countries (Siemens, 2019).

In terms of the engagement with individual SDG, it was found that corporations are selective in deciding which SDGs they would like to engage. Some SDGs can give an edge in the fierce competition with other companies (Schramade, 2017). SDGs such as SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action), which help address cost efficiency, the well-being of employees, and improve the branding image of corporations, are the most popular SDGs among the Fortune 500 corporations. Previous studies also pointed out that corporations prefer to disclose their engagement close to their core business (ElAlfy et al., 2020). SDGs like SDG 2 (Zero Hunger) and SDG 14 (Life below Water) may not give a clear advantage for businesses, which received the slightest interest from the Fortune 500 corporations. How to balance and encourage the business industry to engage with more SDGs is pending discussion.

Engagement with individual SDG varies significantly across industries. This could be associated with the profit, the education level, awareness of employees, and the role of industries in society. For instance, high profitable industries such as Information and Technology industry have the highest engagement across the more significant industry categories. It may be due to the high profit in this industry, and their employees are generally highly educated. However, with a vital role in society, health care is the least prepared industry to transform towards achieving the SDGs. This finding concurs with the situation under COVID-19. The health care system in multiple countries is under the pressure of getting sustainable and flexible support from administrative and resources aspects. When taking a closer look, heavily polluting industries such as petroleum refining companies engage the most with the SDGs. Nevertheless, considering their contribution to the economy and society and the amount of pollution emission, their engagement with the SDGs may still need to be improved. These findings imply that every industry has its uniqueness. It is essential to evaluate the role of individual industry to society and the sustainable future of humankind when setting targets to assess their progress towards adopting the SDGs.

The present study calls for regular and continuous efforts to monitor the progress in business sectors. Compared to the possibility of affecting the decision at the city or country level, corporations are much easier to be affected by policymakers, customers, marketing competitors, the general public, and other sources. Monitoring the engagement with the SDGs in the business industry can help to provide data, raise the competition among corporations, add advantage to businesses with strong social responsibilities and heavy engagement to our planet's future, and hence accelerate their path towards engaging with relevant SDGs. Governments could provocatively encourage and regulate business sectors to engage with the SDGs for a sustainable future. For instance, governments could form regulations to uniform how corporations disclose their engagement with the SDGs. The governmental agencies can set primary targets to regulate the commitment of corporations to the SDGs. Meanwhile, stimulation policies should be implemented to promote the corporations that are proactively participate in the SDGs framework, disclose the relevant data and release their annual SDGs report or develop the SDGs-oriented strategies. Governments and future research can also investigate further the potential barriers that hinder the engagement with SDGs in the business sectors to help them in the transition toward sustainability. The barriers can be a lack of sustainable-oriented suppliers on their production supply chain or a lack of sustain-

able awareness of higher management in the business sector, among others.

5. Conclusions

The present study evaluated the engagement of the Fortune 500 corporations with the SDGs framework across business sectors and categorized their meeting into different levels. It revealed that Europe, Middle East & Africa (EMEA) region is leading the SDG engagement compared to Asia-Pacific and the Americas. The U.S. and China have the most significant number of Fortune 500 corporations, while their engagement with the overall SDGs framework is pending improvement. SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action) are the most popular SDGs among the Fortune 500. At the business sector level, the information & technology sector has the highest engagement rate to the overall SDGs framework across all industries, whereas the health care sector has the lowest engagement rate with SDGs among all the sectors analyzed. Engagement with the individual SDG may be linked with the intrinsic characters of each industry. Although the overall engagement rate is encouraging among the Fortune 500, the engagement depth varies significantly across industries and countries. The findings revealed the current status and potential gaps of the SDGs framework across countries and business sectors. Our findings call for actions from national and subnational governments to better evaluate the SDGs' implementation across the business sector and provide policy preference to corporations that are more willing to participate and implement the SDGs in their business planning. The categorization method in this work can be applied to monitor the SDGs engagement among business sectors over the years.

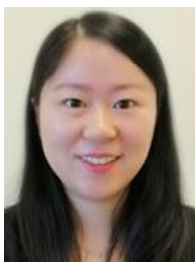
As the first detailed assessment of industrial engagement towards the SDGs framework and individual SDG, we have only included the Fortune 500 corporations. All the data was collected and analyzed manually. Hence, this study gives a lead on how the top players in the business sectors perform in achieving the SDGs, but it is not the whole picture. Future research could focus on automatically collecting data from a much larger sample size and developing systematic and comprehensive evaluation tools to assess the progress of SDG pathways in business sectors. In addition, even among the Fortune 500 corporations, some companies don't have an English website, and the website of one of the America-based companies was broken. These facts added barriers to data processing. Besides, how the SDGs engagement is demonstrated in each company's report or the website varies in style and details. As one of the first few studies in this field, our findings not only lay a theoretical foundation for future research to quantitatively evaluate the engagement of corporations towards the SDGs framework but also call for attention from top business players to form a universal way to disclose their engagement with the SDGs framework.

Declaration of Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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CRediT authorship contribution statement

Lan Song: Conceptualization, Investigation, Methodology, Data curation, Writing – original draft, Resources, Writing – review & editing. **Xiaojiao Zhan:** Data curation, Formal analysis, and Writing – original draft. **Huahan Zhang:** Visualization. **Ming Xu:** Supervision, Writing – review & editing. **Jianguo Liu:** Supervision, Writing – review & editing. **Chunmiao Zheng:** Funding acquisition, Supervision, Validation.

Supplementary materials

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