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Pharmaceutical Supply Chain Sustainability under the Torchlight of Social Media

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ABSTRACT

This research aims to explore the challenges and opportunities associated with the deployment of social media to improve supply chain sustainability. This exploratory research can lead to deeper insights regarding the opportunities as well as problems experienced due to the use of social media in supply chains. The study selected a three-phase Delphi study approach with both qualitative and quantitative analyses. This study recorded feedback from 34 experts with sufficient knowledge of information technology and sustainable pharmaceutical supply chain. 48 independent constructs separately in enterprise and public media were extracted. All the constructs were ranked, ultimately leading to 10 major constructs which played a significantly crucial role in the sustainability of supply chains. While social media challenges and opportunities in supply chain sustainability are discussed in this article, further studies on social and environmental sustainability and providing operational solutions to these challenges are still needed. No paper has directly extracted the impacts of social media specifically on enterprise and public media individually. While most papers mainly focused on economic and environmental sustainability, this paper pays close attention to sustainability and social media.

Keywords: *ESM (enterprise social media), delphi study, PSM (public social media), social media, supply chain sustainability*

1. INTRODUCTION

Today, Businesses face the problem of sustainability as there are serious issues that can cause many social and environmental challenges, such as ignoring human rights and global warming. These problems, inevitably in the long-term, negatively influence the income of the firms resulting in also economic problems. Supply chains play a crucial role in businesses and form the most important part of commercial relations (Shokouhyar and Seddigh, 2020). According to a number of researchers, the establishment of sustainable supply chains makes businesses capable of not only reducing their costs but also discovering new sources of income (Hong *et al*., 2018). Such supply chains produce sustainable products which is vitally important (Arabi *et al*., 2017) and deploy sustainable transportation methods that are vitally important to boost sustainability in businesses (Goyal *et al*., 2021). These approaches ultimately solve many social problems and conserve the environment as well as alleviate economic problems. Thus, in order to make businesses sustainable, supply chains must become sustainable. A Sustainable supply chain has important dimensions, including human rights, labor, environment, and Anti-corruption. Furthermore, supply chains form a gigantic network of information that can provide big data regarding those dimensions.

According to a number of studies, social media is increasingly becoming an important component of the business context (Bitiktas *et al*., 2020). Social media is widely discussed as a public channel through which companies disseminate information and forces companies to tell the truth. These platforms also established an interactive communication context for individuals and business entities (Surucu-Balci *et al*., 2019) and social media users do not seem to be restricted to only individual people, because social media plays the role of a platform for organizations, businesses, and brands (Clure *et al*., 2019). Therefore, social media involves big data related to supply chain dimensions. Social media with specific design and objectives can be used by businesses in their internal context, an instance of which is Enterprise social media (ESM). ESM ensures accessibility of employees' knowledge and resources required for effective group work and dealing with business challenges. ESM platforms can dramatically transform social interactions at work as it enables individuals to learn who knows what and who knows whom, and therewith facilitates communication along with collaboration across the organizational context (Qureshi *et al*., 2018).

Logically, this question comes to mind to what extent can social media contribute to supply chain sustainability? This question provides a rationale for this study since it is

necessary to explore more about the relationship between sustainable supply chain management and social media. Thus, this paper attempts to apply Delphi technique to explore the challenges and opportunities associated with the impact of deploying social media on supply chain sustainability.

This article aims at answering the research questions:

1) What are the opportunities and challenges regarding the analysis of the information shared by public social media throughout sustainable supply chain?
2) What are the opportunities and challenges regarding the implementation of corporate social media throughout a sustainable supply chain?
3) How is the prioritization and ranking of the determined constructs based on their importance?

The rest of the article has the following structure: The major works in literature associated with the topic will be reviewed. In the next section, the research method which used Delphi study is presented. The next part includes the findings and general results of this study and finally, the discussion and conclusion are presented to give insights into the opportunities and challenges associated with deploying social media to make supply chains sustainable.

2. LITERATURE REVIEW

2.1 Sustainable Development

The primary concepts of sustainable development were introduced unofficially since the 1950s and were related to the aspect of human development being associated with the environment and future generations (Rao and Holt, 2005). The United Nations held a conference on Human and Environment issues in Stockholm in 1972. This conference announced actions and commitments required by governments and international organizations to conserve environment (Paglia, 2021). The world commission on environment and development (WCED) provided a report named “Brundtland” in 1987. Here is when the concept of sustainability was formally introduced (WCED, 1987). This report, titled “our common future”, has widely discussed the issue of sustainable development and characterized the concept of sustainability as managing the processes of current development with no damage to the capabilities of future development. Afterwards, Ellington (1994) stated that three dimensions of People, Planets, and Profits. In 2015, The UN held a summit and introduced 17 Suitable Development Goals (SDGs) which include 169 targets. This framework is the 2030 agenda (United Nations sustainable development summit, 2015).

2.2 Supply chain sustainability

Based on the Documents of the UN sustainable development summit, supply chain member companies must commit themselves into stabilizing their firms and the whole supply chain (Brown *et al*., 2016; Rasche, 2020). To this end, The UN introduced a document which clarifies the fair share of supply chains in sustainable development.

This document is a formal agreement that encourages all businesses to follow socially and environmentally responsible law and order and report on their participation in forming sustainable business networks and supply chains (Shokouhyar and Seddigh, 2020). The global compact comprises four facets including Human rights, Labor, Environment, and Anti-corruption from which ten supply chain sustainability principles are derived (Ayuso *et al*., 2016). It is important to mention that one study introduced the eleventh principle for this document that is fight against money laundry practices (Rose, 2019).

Thus, the concept of sustainable supply chain management (SSCM) is brought up. SSCM is obtaining significant importance as a useful tool which helps businesses promote their competitiveness and at the same time, take care of social and environmental responsibilities (Nada R. *et al*., 2019).

The main issue against making firms sustainable is that sustainable practices may not be economically beneficial to companies in the short-term (Ghadimi *et al*., 2019; Hollos *et al*., 2012) and are likely to be useful for them in the long-term and can create competitive advantages over rivels (Ghadimi *et al*., 2019). Thus, in order to motivate these companies, decision makers must offer incentives to them such as media and reputation, awards, innovation, and technology (Shokouhyar and Seddigh, 2020). However, there is a desperate need for a framework which exactly determines the scope and of actions and specific targets (Seddigh *et al*., 2022; Silva and Figueiredo, 2020).

In addition, since each industry faces its own challenges, these frameworks must be specialized for each type of industry. For instance, in hospitals as a member of the health supply chain, there are different obstacles against sustainability such as “reduction in solid waste, compliance with applicable environmental laws and regulations, water usage efficiency, training and education of employees, return on investment and safety equipment for employees” (Weaver, 2022, Nagaria *et al*., 2021; Mirzai *et al*., 2018).

A number of researchers indicated that sustainable supply chain design involves three major structures (Shokouhyar *et al*., 2020; Bals *et al*., 2018), including “Social product model”, “auxiliary financial chain model” and “positive externalities model” which are designing of new products and services, facilities to develop these innovative ideas and suitability and play a crucial role in services supply chain (Ramish *et al*., 2022).

Green supply chains that produce green products also have received attention since they are considered as environmentally friendly networks (Tundys and Wisniewki, 2020). Thus, decision makers have to select primary materials that are suitable for producing recyclable goods (Malviya, *et al*., 2018). Logically, another important decision is supplier selection (Cole *et al*., 2019).

When the supply chain is sustainable, it means it is enabled to project many unpredictable events. Ghadimi *et al*., 2019). In addition, it can adapt to new changes and factors and respond quicker. In case of any disruptions in the supply chain, some impacts like reduced sales and increased costs are inevitable; therefore, it devalues the company's shares (Katsaliaki *et al*,2021). Since in 2020, the World Health Organization (WHO) recognized Corona as an infectious disease which definitely makes the situation even worse. Because supply chains failed to maintain their logistic capabilities. Therefore, they need a lot of attention and the right procedure in place (Pourazari and Doulabi, 2021; Tirkolaee.B, 2021).

2.3 Social media

According to literature, social media is made up of two major categories. Public social media (PSM) and Enterprise social media (ESM) (Liu.Y, and Bakici.T., 2019). Public social networks are websites created by organizations that allow individuals and groups to interact with each other online for example, websites and messengers such as Facebook, Google+, and LinkedIn. They are not affiliated with particular organizations and have a general approach. Whereas, enterprise social media is generally associated with industrial structure by which employees can share information about their commercial affairs that is mainly related to their organization.

Enterprise social media is used for a variety of reasons such as improving innovation management (Tierney *et al*., 2013; Kane *et al*., 2014) or providing social collaboration. In recent years, ESM has been deployed in many organizations, since employees' work performance would be improved through the enhancement of internal communications, the sharing of knowledge, and facilitation of cooperation through ESM (Cai *et al*., 2018).

ESM usually integrates several social technologies aimed at supporting cooperation of the customers; therefore, it is possible to define such platforms as those based on web, making workers capable of (1) communicating messages to certain colleagues or broadcasting messages to other organizational members; (2) explicit or implicit reference to certain colleagues as their communication partners; (3) positing, editing, and sorting text as well as files associated with themselves or others; and (4) viewing the messages, connections, texts, as well as files which others communicate, post, edit, and sort across the organizational context whenever chosen by them.

Currently different ESM platforms including Yammer (Microsoft), Tibber, Jive, Workplace (Facebook) and Connections (IBM) are available. ESM enable social workflow and facilitate communication as well as cooperation related to work, and consist of message activity streams, wikis, micro blogs, blogs, discussion forums, groups, recommendation engines, tagging and secure communities. ESM also assist organizations to crowdsource, openly innovate, or include external experts in internal organizational procedures. Market studies show a considerable increase in investments in ESM currently. Since many ESM platforms are similar with public social media platforms, employees' general attitude towards social media platforms could also influence the engagement of ESM in the organizations, regarding accessing/sharing information and social interaction on social media platforms (Liu *et al*., 2019).

2.4 The relation between sustainable supply chain and social media

In a number of papers, scientists have addressed the issues, barriers, risks, and challenges about sustainability facing supply chains that are not dealt with despite tremendous efforts by managers and researchers (Vishwakarma *et al*., 2019; Wang and Jie, 2019). Different studies on supply chains have reviewed the important role and value of information in efficient supply chain management. In particular, big data presented by social media such as Twitter, Facebook provides us with valuable and timely information about supply chains and can also be very effective in achieving sustainability goals (Karuppiah *et al*., 2021; Shokouhyar *et al*., 2020). In other words, social media has been so effective to improve the performance of different supply chains and create opportunities for everyone to express themselves and discuss the problems they face (Reisach, 2021, Nisar *et al*., 2019). They can point out items that are vitally important since they must have been hidden from decision makers and experts. For example, a number of workers are being oppressed by the chief managers which is related to the social aspect of sustainability. Then these workers have the chance of reporting this issue through social media which is a big step through sustainability or people can report that a factory is contaminating the environment by entering industrial waste to a river which is related to environmental sustainability. This data creates considerable levels of awareness regarding wages, conditions of employment, equity, safety and conditions living among different stakeholders (Xu *et al*., 2021; Lindsey *et al*. 2013; Shokouhyar *et al*., 2021).

In addition, a number of studies emphasized that big data gathered from social media has been very effective in disaster resilience in supply chains by monitoring the real time tweets. (Ragini *et al*., 2018) Vayansky *et al*., 2019).

Furthermore, some researchers believe that social media has been able to raise the innovation and the quality of products of organizations (Liu *et al*., 2021; Tseng *et al*., 2019) as well as improvement in forecasting and inventory management, logistics, distribution processes (Huang *et al*., 2018). The level of customer satisfaction is linked with sentiment analysis as people find opportunities to state their opinions on social media (Trovato *et al*., 2020).

According to current academic works, social media in the case of proper application, reflects a robust instrument capable of dealing with numerous challenges in supply chains. Hence, this logical question is raised that whether social media (public & enterprise) is also effective in supply chain sustainability, and what challenges its implementation will have.

Previous research has established a background about the relationship of social media and supply chains, but no research has precisely illustrated the independent constructs from social media impacts on sustainability separately regarding public and enterprise media, or assessed the opportunities as well as challenges experienced by corporates and supply chain domains (Tseng *et al*., 2019).

After a comprehensive review on literature, it can be said that although possible advantages of the integration of digital technologies and supply chain management is extensively documented by scholars as well as practitioners (Kamble *et al*., 2020), so far few studies have been conducted on the quantitative and qualitative integration of information or considering contribution of social media to the management of supply chains, along with examining the chances as well as challenges created by public and enterprise social media in supply chain sustainability. A number of studies suggested that researchers should explore the benefits and challenges faced by companies when they attempt to use social media for sustainability since the contribution of social media to the business management can be significant since it is possible to enhance the efficacy of sharing information and managing knowledge through social

media (Tseng *et al*., 2019). Thus, this study decided to focus on the issues which can be inferred from social media, providing us information that is impossible to get anywhere else. But to integrate social media and sustainable supply chains, there are serious challenges and opportunities that must be detected and discussed.

3. RESEARCH METHOD

According to literature and research gap, new study is necessary to discover opportunities and challenges regarding the analysis of the information shared by corporate and public social media throughout sustainable supply chain and how these constructs are prioritized in order of importance. These are summarized as research questions that were presented in the previous sections. To conduct this research, Delphi study is deemed suitable since extensive knowledge and expertise is required in extracting and analyzing constructs related to opportunities and challenges of deploying of social media to boost sustainable supply chain. The classical Delphi method (Bao *et al*., 2019) was considered to be appropriate for gathering of empirical data and the means of giving insights into challenges and opportunities that sustainable supply chain will face when it comes to benefiting from social media (Nguyen *et al*., 2019). Delphi survey has also been recommended for predicting the effects of new technologies like social media on sustainability of supply chain (Jiang *et al*., 2017). A number of studies have stated that a classical Delphi method can be modified based on different situations to become compatible with the circumstances as much as possible (Jesus *et al*., 2019). A number of researchers have compared classical paper-based method with e-mail-based method and concluded that there is no difference between their outcomes and results. In addition, the process of conducting Delphi method via mailing or online methods was more effective and faster than traditional survey group (Belton *et al*., 2019; Fritschy and Spinler, 2020; Munoz *et al*., 2019). An online survey tool allows experts to participate in the study regardless of their physical location. As the strength of this approach heavily depends on the way in which it is conducted (Bolger and Wright, 2011), very close attention was paid to each stage. The feedback of each of the experts was documented at every step of the investigation, and all changes were recorded in a systematic way to guarantee the validity and reliability of the results.

Despite the increasing use of social media analysis in management, there are limited empirical studies in this area. Therefore, because of limitations in access to comparable cases along with challenges to comprehensively obtain and analyze feedback from managers as well as experts, the Delphi (Bao *et al*., 2019) seemed suitable to collect the empirical data. This method is also employed in the prediction of the effects of novel technologies on social and economic dimensions of business entities, supporting its effectiveness in conducting forecasts (Jiang *et al*., 2017) and coming to consensus (Jesus *et al*., 2019). This qualitative technique was supposed to make a group of experts capable of discussing and making decisions on policy with no face-to-face communications.

3.1 Selection and classifying the expert panel

Based on literature, about 18 participants were deemed to be enough for this type of study (Jesus *et al*., 2019; Briel.F, 2018; Kache and Seuring, 2015). However, we initially invited 53 people to this study. They were then asked to nominate other people to participate in accordance with the panel selection criteria. 27 people were identified as eligible, two of whom were previously selected, and 25 were added to the panel. Then the introduction process for the second group was carried out, and they identified 10 other eligible individuals who were not in the previous groups, and the other group did not identify the person who was eligible to participate in the survey. Therefore, a total of 53 people were selected to participate in the Delphi study. But as mentioned in the next section, finally 34 participants in all stages of our questionnaire accompanied us. Given what was recommended by Belton *et al* (2019), the number of experts seemed suitable for the sample of the study. The sample was chosen form different countries and businesses with different supply chains. They had one of the following characteristics:

1. Managers or senior consultants in sustainable supply chain or similar areas such as marketing management.
2. Managers or senior IT specialists, especially social network analytics and Big Data.

They were then following Rowe *et al*. (1991), divided into two groups according to their background. One group included 20 people with technical background in IT issues (IT Manager and IT Senior Expert) and the other group consisted of 14 people with management background (Marketing Manager and Supply Chain Consultant). **Table 3** shows the members' work experience by their type of work. Assignment of the experts into various groups aimed at ensuring the provision of accurate answers and consequently demonstrating internal validity (Bao *et al*., 2019).

Table 1 Expert Numbers and Nationalities

Type of Work	Number of invited experts (number of final participants)	Countries of the final Participants (Iran (Ir), Canada (Ca), China (Ch), India (In))	Work Experience (Year) of final participants		
			Max	Min	Ave
IT Manager	9(6)	1(Ir),3(Ca),4(In)	24	12	14.63
IT senior experts	17(14)	3(Ir),2(Ca),4(Ch), 5(In)	13	7	8.75
Marketing Manager	20(11)	5(Ir),3(Ca),3(Ch)	26	9	15.53
Supply Chain Consultant	7(3)	3(Ch)	23	14	18.3

3.2 Study Design

Delphi data collection operations were performed in May, June and July 2019. Feedback from the experts was recorded through a three-phase study. It seemed essential to limit the number of surveys as to many phases could decrease the likely of the experts' engagement and would subsequently reduce the response rate (Munoz *et al*., 2019; Melander *et al*., 2019; Jesus *et al*., 2019). We tried to talk to experts by face-to-face manner. We had meetings with those

who were in Iran in their office and with whom from the other countries via Skype. During the three-step process, using three questionnaires, experts had to submit their feedback and responses over a two-week interval after receiving the questionnaires, via email. If no response was received from participants during this time, emails were sent again and all experts were reminded through phone calls by researchers. Eventually, if no response was received from either participant, the person would be excluded from subsequent surveys, which unfortunately despite the researcher's attempts to collect the experts' responses, 12 experts withdrew from the study over phase 1, and 7 over the second phase, leading to a number of 34 experts. But fortunately, these experts were so dominant and were connected to a huge network of information. Our focus was on the quality of the expert's knowledge and their number was not very important. because We strongly believe inserting unqualified experts can distort research results. It should be noted that before submitting any questionnaire at each stage for validity of the work, the questions were first tested by two senior experts for accuracy and completeness.

3.3 Data Collection

The design of the first-round questionnaire was open-ended in which each participant was required to freely write 3-4 opportunities and challenges for each of the two questions below, each divided into two sub-questions to guarantee accuracy of the responses as much as possible:

1. What are the impacts of public social media on the sustainability of supply chains (regarding both opportunities and challenges)? What are the effects of enterprise social media on the sustainability of supply chains (regarding both opportunities and challenges)? At this round, 807 responses were received by 34 participants. These cases were then summarized and grouped, and finally, 48 separate cases involving challenges and opportunities were identified in both domains of public and enterprise social media (**Table 3**).

Table 2 The Open Questions, Answer Items and Number of Extracted Constructs

Questions	Sub-questions	Number of answer items/ sub-question	Number of Final Extracted constructs
What are the impacts of social media on the sustainability of pharmaceutical supply chains?	What are the Opportunities of Public Social media in the Sustainability of Supply Chains?	234	13
	What are the Challenges of Public Social media in Sustainability of Supply Chains?	125	10
What are the impacts of enterprise social media on Sustainability of pharmaceutical Supply Chains?	What are the Opportunities of enterprise Social media in Supply Chain Sustainability?	293	15
	What are the Challenges of enterprise Social media in Supply Chain Sustainability?	155	10
Summation		807	48

3.4 Data analysis

Evaluation of all 807 responses gathered in the first phase was conducted, and the qualitative cluster analysis (Revelle, 1979) was performed to extract similarities between them. The items with similar concepts were integrated, finally leading to 48 constructs. After collecting and summarizing the answers in the first round, the researchers used 5-point Likert scales, at a range of "very high" (5), "high" (4), "medium" (3), "low" (2) to "very low" (1), for rounds 2 and 3 to prioritize the constructs. And also, 0 indicated that the item was non-applicable. In round 2 of the questionnaire, prioritization of the 48 identified constructs and their ranking in terms of importance were performed by the participants, after which the responses were submitted. Then, based on the answers and scores given to each construct, the "mean" was calculated which made it easy to compare each item with the other. Then, the researchers sorted the constructs by descending order of average to determine the highest scorings in each subdivision. If the mean of each item was the same as the other items, they were ranked based on "very high" and "high" scores. In round 3, the primary prioritizations for every construct were provided for the experts after contrasting with the estimated group mean average score for the same construct. Then they were asked to examine their initial prioritization and compare it with the mean of all participants' responses and express their opinions if required. Finally, slight modifications were proposed. It should be noted that SPSS software version 26 was employed to conduct data analysis in this paper.

3.5 Validity, reliability, stability and replicability

The internal validity of this research is guaranteed by the iterative manner of the survey and the robust composition of the expert panel (i.e., chief managers with great expertise in information technology and supply chain management)

who were connected to a gigantic network of information. This study enabled them to think independently and apply their opinions.

Moreover, at each stage we conducted a pilot study with two senior experts for accuracy and completeness before submitting any questionnaire for validity (Manuz *et al*., 2019). External validity demonstrates the extent to which the final results of a study can be generalized to broader populations (Davis, 2005), which was not a problem in this research as the participants worked in different companies from various countries. Therefore, the study avoided biases in feedbacks and eliminated the problem of "opinion leaders' domination"; the experts were given freedom in completing the questionnaires in a flexible way, so that every expert can think independently and present their intact opinions (Bolger and Wright, 2011).

All the 34 experts who participated in this study are great managers of pharmaceutical supply chains in several countries. In addition, the network of their contact is very broad and they have access to many other experts' viewpoints. No doubt that including unqualified experts, weakens the results of the study. (Nguyen *et al.*, 2019). Furthermore, the size of the expert panel should not be too big that it becomes unworkable, resulting in low response rates and time constrains, and not too small as to ensure representativeness (Jesus *et al.*, 2019). In this study, the number of experts were considered to be enough for both qualitative and quantitative analysis (Jesus *et al*., 2019; Briel, 2018; Kache and Seuring, 2015).

We also checked for a potential non-response bias through grouping the expert panel into early and late respondents. To do this, we conducted a Mann-Whitney test to compare the feedbacks of both groups which there was no significant difference. Thus, the non-response bias was not an issue in this work (Robmannn *et al*., 2018; Briel, 2018).

This research also focused on reliability and since the same results were obtained each time, the test was repeated, so this study has proven to be reliable. (Briel, 2018).

This study applied the Delphi study in three rounds to ensure the transparency of all steps and findings. Therefore, the replicability of this research is verified.

This work also controlled the stability by giving leeway to experts to change their feedbacks if needed regarding the responses of other experts in each round. Thus, the authors controlled the stability (Fritschy & Spinler, 2020; Briel.F,2018; Merfeld *et al*., 2019) and substantial stability was achieved given the implementation of a Delphi study in three rounds involving qualitative and quantitative techniques as well as iterations that continued until a stable conclusion was obtained. However, to provide more conclusive evidence for stability, the Wilcoxon matched-pairs signed-ranks test was carried out between the second and the third rounds which verified there was not any significant changes in responses of the expert panel (Briel, 2018).

4. RESULTS AND OUTCOMES FROM DELPHI METHOD

4.1 The Results of Phase 1

As mentioned before, the experts provided 2-4 opportunities and challenges related to each of the two open questions. Then, the collection and aggregation of the answer items into constructs were carried out considering the frequency of the mentioned issues. Accordingly, a primary list of 31 discriminant constructs was obtained within public and enterprise social media, reflecting opportunities (**Table 4**) and challenges (**Table 4**) associated with the supply chain sustainability.

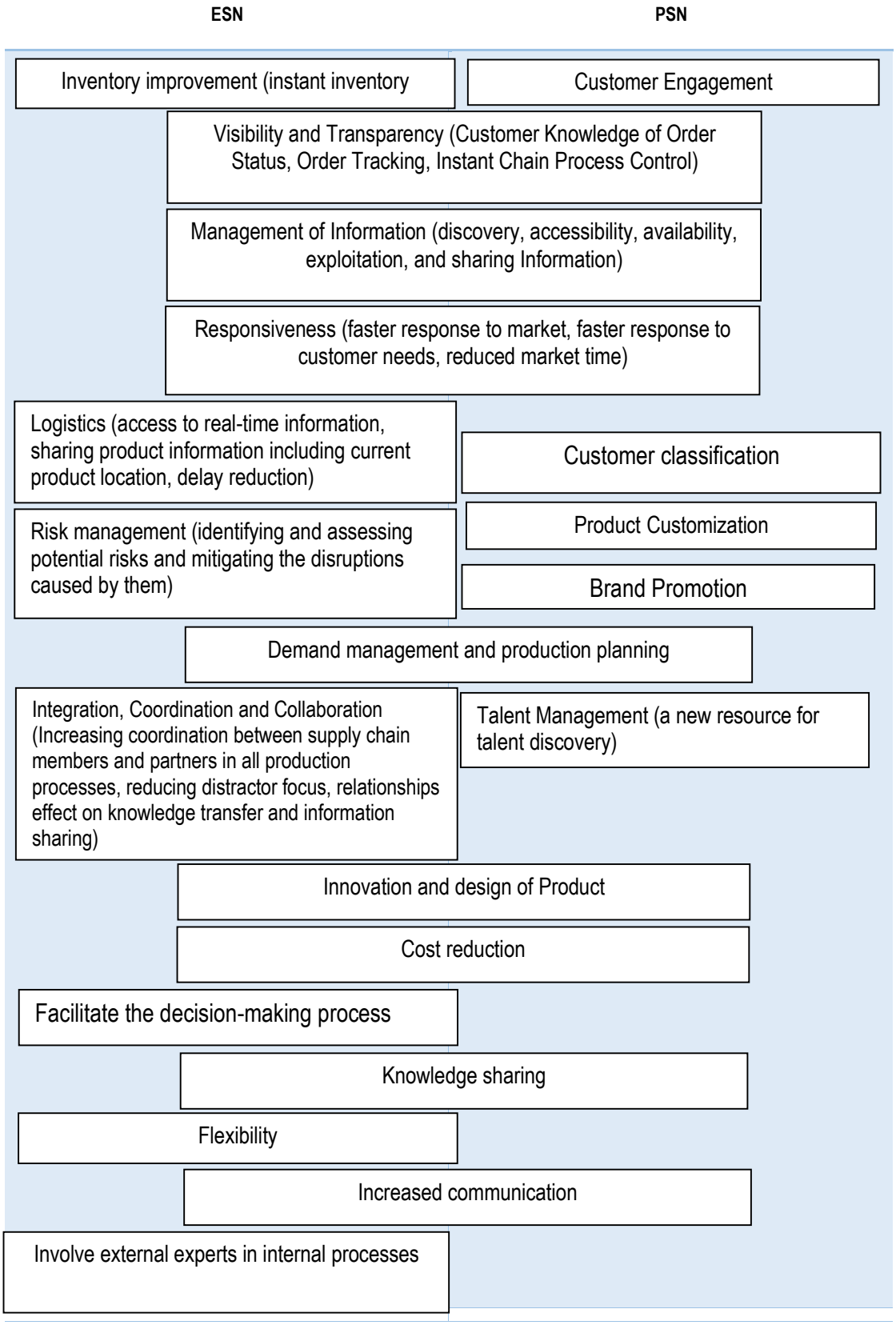

Figure 1 PSN & ESN Opportunities

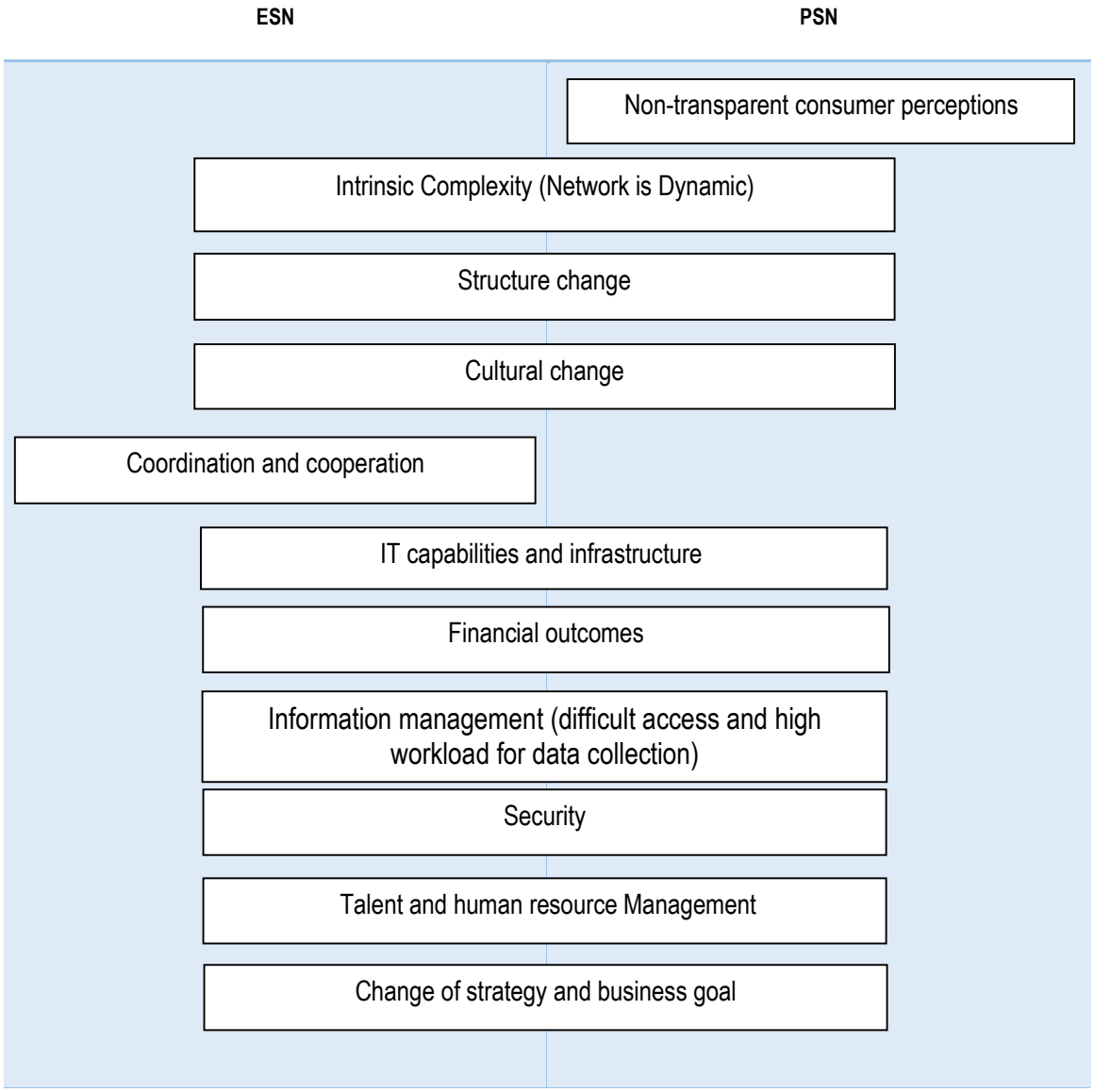

Figure 2 PSN & ESN Challenges

4.2 The Results of Phase 2

The second round was aimed at quantitative evaluation. This phase aimed at prioritizing the opportunities as well as challenges raised in the previous phase. Five-point Likert scales at a range of very high (5), high (4), medium (3), low (2), very low (1) and zero were used. At this stage, participants were asked to prioritize the 48 identified items and rank them in terms of importance and submit their response. Then, based on the answers and points given, the mean for each is calculated, which makes it easy to compare each item with the other. Then, in order to identify the case with the highest score in each subdivision, we sorted it by descending order of average. If the mean of each item was the same as the other items, they were ranked based on very high and high scores. Constructs with a mean of "4" or higher were considered as the most important options.

4.3 The Results of Phase 3

In this phase, participants evaluated and confirmed their initial prioritization in the second round. The purpose of this approach is to improve the overall response quality of the group regarding a higher balance in the distribution of ratings. At this stage, 27 participants resubmitted their initial rankings without any changes and 7 of them made a series of minor changes to their rankings. These changes include changes in the number of ranks won by the three items in the PSM opportunities (e.g., increase in the number of "very high" ranks for the "supply chain visibility and transparency" item) and changes in the ranks gained by the "Information management" and "improving company performance" and moving them up in the table) which had an impact on the average. In the opportunities associated with ESM with changes in the number of ranks of the two items "flexibility" and "increased communication", due to the change in the mean score, the location of the two constructs was moved in the table. But no new option was added to the list.

Table 3 shows the prioritization of opportunities arising from public social networks in the supply chain, as indicated "customer engagement" with a mean of "4.61" is in the first place, "supply chain visibility and transparency with a mean

of "4.41" is in the second place, "Brand Promotion" with the mean of "4.38" is in the third place and "Increased communication" with the average of "4.38" is in the fourth place.

Table 3 Ranking of PSN Opportunities

Opportunity	Number of experts with rating						AVE	SD
	5	4	3	2	1	0		
Customer Engagement	19	15	0	0	0	0	4.63	0.491
Visibility and Transparency of supply chain	15	17	2	0	0	0	4.46	0.612
Brand Promotion	15	16	3	0	0	0	4.33	0.617
Increased communication	15	17	2	0	0	0	4.28	0.711
Responsiveness	13	10	8	3	0	0	3.92	0.998
Knowledge sharing	11	10	9	3	0	0	3.81	0.996
Information management	5	17	8	4	0	0	3.66	0.788
Product customization	6	14	12	2	0	0	3.59	0.923
Customer classification	6	15	7	6	0	0	3.57	1.126
Innovation and product design	4	12	11	7	0	0	3.34	0.366
Demand management and production planning	3	11	16	4	0	0	3.30	0.874
Talent management	0	5	14	10	5	0	2.51	0.826
Cost reduction	0	0	9	12	13	0	1.91	0.912

Table 4 shows the prioritization of opportunities arising from enterprise social networks in the supply chain, as indicated "logistics" with a mean of "4.41" is in the first place, "supply chain visibility and transparency" with a mean of "4.38" in the second place, " Coordination and cooperation" with the mean of "4.32" is in the third place and "Knowledge sharing" with the average of "4" is in the fourth place.

Table 4 Ranking of ESN Opportunities

Opportunity	Number of experts with rating						AVE	SD
	5	4	3	2	1	0		
Logistics	16	16	2	0	0	0	4.42	0.609
Visibility and transparency of supply	15	17	2	0	0	0	4.36	0.604
Coordination and cooperation	15	15	4	0	0	0	4.31	0.684
Knowledge sharing	12	10	12	0	0	0	4.01	0.852
Inventory improvement	10	10	12	2	0	0	3.86	0.936
Demand management and production planning	0	19	12	3	0	0	3.46	0.662
Innovation and product design	0	16	12	6	0	0	3.33	0.811
Risk management	0	14	13	7	0	0	3.19	0.766
Responsiveness	0	12	15	7	0	0	3.17	0.766
Information management	0	12	14	8	0	0	3.13	0.788
Flexibility	0	13	11	10	0	0	3.08	0.839

Table 5 shows the prioritization of challenges arising from public social networks in supply chains as indicated "IT capabilities and infrastructure" with a mean of "4.35" is in the first place, " Change of strategy and business goal " With a mean of "4.14" is in the second place and "intrinsic complexity" with a mean of "4" is in the third place.

Table 5 Ranking of PSN Challenges

Challenge	Number of experts with rating						AVE	SD
	5	4	3	2	1	0		
IT capabilities and infrastructure	16	13	5	0	0	0	4.39	0.744
Change of strategy and business goal	12	16	6	0	0	0	4.17	0.763
Intrinsic complexity	11	11	12	0	0	0	4.02	0.819
Information management	9	12	13	0	0	0	3.79	0.801
Security	8	14	12	0	0	0	3.36	0.779
Cultural change	2	15	12	5	0	0	3.43	0.831
Non-transparent consumer perceptions	0	13	17	4	0	0	3.98	0.662
Structure change	0	8	23	3	0	0	3.23	0.603
Financial outcomes	0	11	18	3	2	0	3.18	0.833
Talent and human resource management	0	4	12	11	7	0	2.49	0.963

Table 6 illustrates the prioritization of challenges arising from enterprise social networks in the supply chain, as it is clear that " Coordination and cooperation" with a mean score of "4.38" rank first, "IT capabilities and infrastructure" with a mean of "4.29 " is in the second place and "change of strategy and business goal " with a mean of " 4 " is in the third place.

Table 6 Ranking of ESN Challenges

Challenge	Number of experts with rating						AVE	SD
	5	4	3	2	1	0		
Coordination and cooperation	15	16	3	0	0	0	4.43	0.661
IT capabilities and infrastructure	12	19	3	0	0	0	4.31	0.654
Change of strategy and business goal	8	17	9	0	0	0	4.04	0.701
Intrinsic complexity	8	14	11	0	0	0	3.96	0.753
Structure change	7	15	10	1	0	0	3.73	0.789
Talent and human resource management	0	14	11	9	0	0	3.16	0.818
Information management	0	12	15	5	2	0	3.13	0.799
Financial outcomes	0	11	15	5	3	0	3.01	0.845
Security	0	12	14	6	2	0	3. 14	0.909
Cultural change	0	4	11	14	5	0	2.49	0.851

5. DISCUSSION

The main opportunities and challenges associated with social media are identified and this paper presents an in-depth analysis and discussion. According to experts' responses and tables presented in the previous section, constructs with a mean score above 4 or at least equivalent were prioritized. **Table 5** presents key challenges and opportunities, according to which some constructs provided show not only importance regarding one dimension. Four constructs were found that appear to be quite significant. The opportunity "Supply Chain Transparency" and the challenges "IT capabilities and infrastructure" and " Change of strategy and business goal" apply to both types of social media, public and enterprise. It was found that it is possible

to consider "integration, coordination and cooperation" at the enterprise social media as an opportunity source, while having several challenges simultaneously. These ten main items will be discussed in the rest of the article.

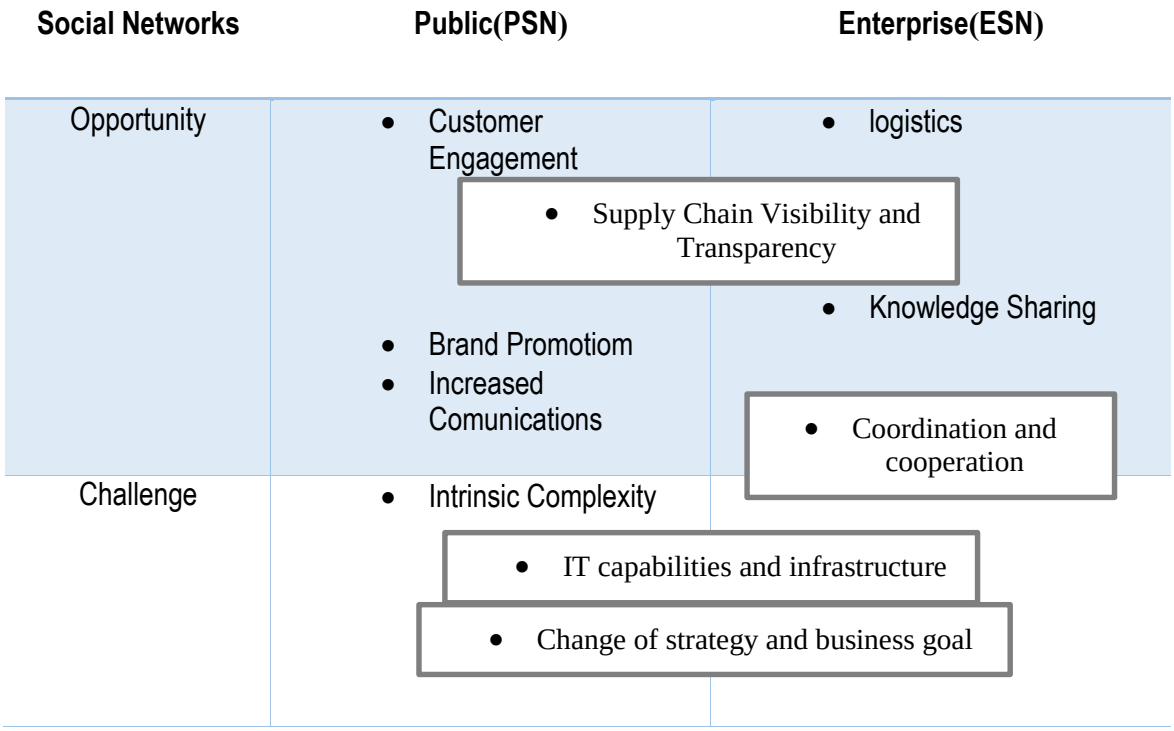

Figure 3 Key Constructs

5.1 Customer Engagement

Today, social media are the most widely used public relations channels on the Internet. Many consumers use digital tools such as smartphones and tablets, spending a great deal of time daily basis. This has created a golden opportunity for organizations to expand their relationship with customers and count on social media for their marketing plans.

Since it is absolutely essential to learn about customer behaviors (Ha *et al*., 2021), it is necessary to establish closer communication with customers and create a personalized experience for them in product and service design. Marketing professionals have to understand customers' needs, and gain a better understanding of customer behavior, interests, preferences, and consumption patterns which will only be possible through improved interactions. This type of approach can be deployed in any stage, from product design to final consumption by end-users.

5.2 Supply Chain Visibility and Transparency

For every business it is so important to have real-time information about raw materials, the semi-finished and the end product. In addition, customers expect to be aware of their order status from the moment the order is placed until the item arrives. Supply chain transparency requires companies to be aware of what is happening at any given moment in the upstream and to share this knowledge inside and outside the supply chain. Transparency includes all the factors that will affect supply chain segments after customer order registration. Understanding the status and position of the product in the supply chain and the conditions under which the product is produced is one of the benefits of supply chain transparency that helps both, customers in selecting products and staffs in managing the daily operations of companies. For example, if a business can predict all the delays in buying raw materials, manufacturing or distribution, can make smarter and timely decisions by for instance changing the suppliers. Social media increase visibility and transparency in the supply chain that considerably helps the companies to have such flexibility in their production plans. In such sharing platforms, all supply chain information on the map can be accessed as it is easy to identify the origin of each part of products which is essential to understand the environmental and social consequences.

The complicated supply chains can be demystified through transparency. Identifying and minimizing the risks will be possible with improving the existing conditions and informing all necessary actions. In fact, information accessibility regarding the way through which supply chain members are associated with sustainability practices will be necessary to make smart decisions on the sustainable investments. It is indispensable help decision makers to decrease the risks facing supply chains, and the most of opportunities (Rueda *et al*., 2016).

In developed countries, based on the governmental regulations, information about the processes of supply chains must be clearly shared for both regulatory measures including moratoria, fines, and taxation and the incentive measures including subsidies and credit lines. Thus, Businesses need to be transparent about their environmental impacts. This does not only mean reporting on the impacts of companies, including greenhouse gas emissions, waste and water use, but also on the environmental impacts of their products over their lifecycle. Furthermore, information about social responsibilities like occupational safety and health,

working hours, salaries and benefits are required by the authorities.

The expert panel strongly believes social media provides the opportunity for organizations especially in the field of fashion, food and tourism to compete healthy and deliver better and more realistic products and services and all stakeholders in the chain benefit from transparency. Such multilayer transparency leads to higher dynamics, flexibility and participation in decision making across supply chains.

5.3 Brand Promotion

Branding is the most influential valuable asset for the companies and social media is a great place to raise brand awareness since billions of people use social media platforms and companies increasingly rely on social channels to reach their audiences effectively (Khan, 2022). However, the increasing complexity of social channels is a big challenge. Platforms like Facebook recognize that marketers need to target audiences and attract them. Thus, theses social media charge companies to allow them to continue advertising in their platforms. In this challenging environment, marketers need a framework for channel prediction and content effectiveness and ultimately promotion of their brand. As a result, successful brands are preferred by a great number of customers who have brand loyalty. Every company should smartly select the type of social media platforms that can attract as many potential customers as possible. For example, Instagram platforms may be preferred to Twitter to interact with audiences.

5.4 Increased Communications

Communication involves the transmission of opinions, attitudes and feelings, either verbally or non-verbally. This transition is especially important in the service sector because service providers act according to human communications (Ramish *et al*., 2022). Based on expert ideas in all sustainable programs or strategies, communication contributes significantly. They believe that managers in an organization have to establish communication channels in a simple, direct and accurate way, whether oral or written. From the economic view external communication with consumers, business stakeholders and the community are essential for sustainable strategies.

Plus, international organizations and governmental sectors can receive information about social issues, environmental concerns and take the necessary actions (Sharifi and Shokouhyar, 2021; Nasiri and Shokouhyar, 2021). Plus, different parts of supply chain can communicate more effectively (Shokouhyar *et al*., 2017). Therefore, it is not possible any more for brands to hide in the shadow of private communication, or cover up the misconducts or activities that are hazardous to the environment.

5.5 Logistics

According to **Table 4**, the expert panel strongly believe that the main opportunity of using enterprise social media in the supply chains is optimization of the inter-company logistics and even reverse logistics (Ahmadi *et al*., 2022).

By using communications through social media, it is possible to trace products across supply chain entities. Accordingly, information such as current product location data shared in real-time between the parties that is useful for the prediction of potential delivery delays over supply chains. Valuable information is collected from social media about transportation and unforeseen issues such as traffic accidents and road closures that affect delivery schedules. Such implications are valuable for making logistics decisions. A logistics system which has sustainability can emphasize logistics measures (like selecting suppliers, procuring, producing, warehousing, and delivery) to decrease the organizational costs, reduce the related environmental impacts and the impacts on the community.

By using social media, the risk management after natural disasters becomes more effective since it is possible to adopt sophisticated strategies to keep the momentum of supply chains. For example, the expert panel believe that avid the pandemic information shared by social media helped decision makers of supply chains to continue supplying the drugs needed by the market. Also, some researchers believe that social media can be useful in reverse logistics, playing a role in making better decisions in reverse logistics operations that is inevitably helpful to alleviate the bull-whip effect. On-time share of information regarding reverse logistics issues among the partners of supply chains in social media makes businesses capable of providing appropriate decisions. It is also suggested that developing models of adopting blockchain systems can significantly improve logistics (Colak and Hakan, 2022).

5.6 Knowledge Sharing

A successful supply chain must be demand-oriented (Basnet and Seuring, 2016) which includes the ability to rapidly utilize and mobilize the entire network of suppliers, sellers, buyers and customers through innovative interactions and flexible business models. ESM facilitates overcoming challenges related to enterprise knowledge sharing including finding experts, stimulation for knowledge sharing and development, and continuing social relationships with knowledge carriers. ESN improves the process of knowledge sharing in multinational businesses by enhancing and supporting relationships and network interactions. The expert panel strongly believe that by knowledge sharing, employees can reach new solutions that can be beneficial to everyone which leads to organization development toward more sustainable activities. knowledge on social media improves employees' skills and technical abilities and also enables highly knowledgeable individuals to be identified and receive appropriate benefits based on meritocracy. Social media provides an opportunity for supply chain members, both suppliers and contractors, to share their knowledge and information on purchasing raw materials which are compatible with environment and developing common ways to reduce waste.

5.7 Coordination and Collaboration

Collaboration among suppliers, manufactures and customers with the eventual goal of achieving customers' satisfaction is a critical factor (Arvitrida *et al*., 2017). Integration and collaboration and the culture of interaction throughout the supply chain results in higher amounts of information exchange between the parties. Accordingly, this approach towards collaboration in share of information which is identified as consolidated data exchange platforms is one of the key opportunities in the entire supply chain. This

phenomenon reinforces transparency across supply chains since it helps all members of supply chain to cooperate with each other to develop sustainable operational processes that are environmentally friendly. A number of members' unwillingness for cooperation may be one of the main issues which can be due to the fact that the advantages of joint endeavors do not appear immediately. However, experts' judgment has shown that increasing level of coordination can reduce supply chain risks as it creates big opportunities to exploit shared information.

5.8 IT Capabilities and Infrastructure

IT capabilities play the role of a vital enabler in SSCM since it creates the necessary tools and interactions for sustainability practices (Shokouhyar *et al*., 2018; Khan *et al*., 2019). The expert panel believe that both internal and external networks require significant infrastructures and proper applications as well as skilled people to gather, integrate and analyze data. This paper believes that providing powerful infrastructures, advanced technology, smart processes and skilled people will be the main challenges in the processing of the real-time information in a digital business context. The expert panel argued that lack of proper infrastructure makes it difficult for companies to collect, share, and analyze information to carry out sustainability measures.

5.9 Intrinsic Complexity

Social media can be regarded as a kind of complex systems because these systems include a great deal of components. Moreover, sophisticated strategies are required to from a gigantic network of information such as machine learning (Aamer *et al.*, 2020). Social networks contain numerous elements which may result in significant heterogeneity. The structure of these interacting elements has a complex architecture. The data and content shared between entities are very large and unstructured which are being disseminated at high speed. Data content transfer methods among individuals and other agents also need to have specific and relevant rules. Thus, a vitally important action is establishing a new set of regulations and structures. In fact, complex systems are diverse and ambiguous with unpredictable outcomes regarding the input or change of conditions. Given the interactions of three dimensions that are components number, relationship variety, and pace of change, it is not possible to simply predict what a complex system is supposed to be carried out. Generally, when a system includes more people and more complicated structures, it will face more complexities.

5.10 Change of Strategy and Business Goal

Since social media brings big data which plays a crucial role in decision making (Bahrami and Shokouhyar 2022, Jeble *et al*., 2018), companies should consider social media as a formal marketing tool that requires a specific strategy. Data mining is another effective factor for decision making (Shokouhyar *et al*., 2017). Some businesses believe that social media need not be taken seriously, but in fact, the use of social networks should be a formal approach involving business objectives, audiences and competitors, social media channels, contents and resources. Each social media channel is different from the others, so a new strategy must be defined to use each. Defining a clear goal for the use of social networks as well as the need to integrate them into corporate business strategies can be mainly challenging for the firms. Because of the dynamics of social networks or the emergence of a new generation of desires or technologies, the strategy may be revised and refined several times (Shokouhyar *et al*., 2012). Thus, a dynamic system is required to review and update strategies on regular basis.

According to experts discussed above, the **Table 10** summarizes which aspects of sustainability each challenge or opportunity will affect more.

Table 7 Impacts of Key Constructs on Sustainability 3 Dimensions

Sustainability / Construct	Environmental	Social	Economic
Customer engagement	• Design, product and present the sustainable products and services	• Introducing lesser-known businesses for collaboration • Identify suitable and qualified people for cooperation	
Supply Chain Visibility and Transparency	• Understanding the conditions under which the product is produced • understanding the environmental consequences by tracking the origin of products and services	• Understanding the human rights consequences by tracking the origin of products and services • demonstrate that a business adopts environmental and social standards	
Brand Promotion	• successful brands, have the power to modify	• successful brands, have the power to modify	• Consumers willing to buy brands that meet

Sustainability / Construct	Environmental	Social	Economic
	consumers behavior with environment	consumers lifestyle and attitudes	environmental and social standards
Increased Communications	• Leads to clarify environmental issues and concerns and take action to reduce them	• Leads to clarify social issues and concerns and take action to reduce them	• Customers feel comfortable with businesses and the possibility of buying and receiving more services from them
Logistics	• Reducing the destructive effects of the chain on the environment	• Improving the quality of working conditions and increasing employee productivity	• Reducing the risk of accidents
Knowledge Sharing	• Identify sources of environmentally friendly raw materials and provide solutions to reduce environmental impact	• Discovering specialists, improving the skills of employees, establishing justice in the payment of salaries	
Coordination and Collaboration	• Business partnerships with suppliers to ensure eco-friendly activities	• As challenge: Differences in goals and interests of employees and different managements	• Risk reducing
IT Capabilities and Infrastructure	• Lack of proper infrastructure and experts is a challenge in processing shared information.		
Intrinsic Complexity	• The inherent complexity of social media, including the components number, the platforms variety, and the speed with which information changes, makes it difficult to control their data.		
Change of Strategy and Business Goal	• The use of each social media requires its own unique strategy, the dynamics of social media and technological changes modify the strategy of businesses.		

6. RESEARCH IMPLICATIONS

This research has considerable theoretical implications in future studies. The researchers are highly encouraged that to introduce frameworks, step by step to integrate social media in different supply chains. Since each type of supply chain has its own specific features, these frameworks will be specialized based on the kind of industry. Furthermore, scientists are highly likely conduct studies to localize their models as each region is strongly influenced by items such as culture, religion and law. Researchers also are encouraged to find out that which type of social media is the best option to each industry and region. It is highly recommended that researchers pay attention to sentiment analysis and the way people express their feelings on social media. No doubt that strong big data infrastructures are needed to gather data and analyse it and then turn it into useful and timely information. Data Scientists are likely to be interested in these projects.

This study identified opportunities and challenges but future and in-depth studies are required to find effective solutions to these challenges. Plus, several mechanisms must be designed to optimize the opportunities because making the most of the opportunities, is another challenge that needs serious attention.

7. PRACTICAL IMPLICATIONS

The current paper sought to deal with failure to use social media for sustainable performance. Limited research has indicated the influence social media exert on sustainability, and none have focused on the opportunities and challenges which social media (public and enterprise) will bring to firms to be sustainable. This study can help decision makers and managers understand functional application of social media in sustainable activities. The results provide 7 key constructs in terms of opportunity: Increase customer engagement, supply chain visibility and transparency, communication, coordination and cooperation, knowledge sharing and improve logistics and brand of a firm. These opportunities indicate the importance of social media on sustainable supply chain. It is necessary to discuss and apply them to business activities for performance enhancement by chief managers. And also 4 key challenges including: intrinsic complexity of social media, coordination and corporation, IT capabilities and infrastructure, and change of strategy and business goal of a firm have been discussed as root problems resulting in other different challenges and issues. Chief managers must pay more attention to them before considering the use of information which are accessing from social media platforms on a large scale. In addition, as the United Nations emphasizes on

sustainable development of organizations and companies, this study can provide practitioners the insights into the opportunities that social media creates for sustainability. And also, the results of this study can force governments to adopt strategies to deal with the challenges facing organizations regarding application of social media, such as the lack of adequate information technology infrastructure.

8. CONCLUSION AND STUDY LIMITATIONS AND FUTURE STUDIES RECOMMENDATION

Sustainable supply chain remains as a global concern and amid Corona pandemic the situation even deteriorated into a collapse of many supply chains. According to academic evidence social media is powerful tool to solve problems in terms of decision making. In this study, we were able to find the answers of research questions, independent constructs of opportunities and challenges in terms of data analysis gathered through general and corporate social media about supply chain sustainability and their order of importance.

The findings of the Delphi technique in this study by identifying and comparing 48 opportunities and challenges in using social media considering public and enterprise media collected by experts led to the identification of 10 key cases in both domains. Each sub-section has been thoroughly discussed and finally identified four common items between the two areas that are of great importance and will be of great benefit to organizations and managers. Full understanding of these issues is a key factor for competition and productivity of the whole supply chain. This research contributes to the existing knowledge in the field of social media and supply chains and can be the basis for future studies in related fields.

Although the utmost care was taken in this research, there are some limitations. First, obviously, if the number of participants were more, the results would be of higher quality but the present work focused primarily on managers and decision makers as the experts who had no adequate time to cooperate in all the three phases. Thus, maintaining their cooperation in the research to cover all three phases of Delphi method was very challenging and because of this limitation the results are not generalizable to the whole world. Second, the results of this paper are limited to the expert's opinion, and no objective measures have been taken according to real-world data. Finally, the present work discussed on only 10 key constructs, not all of the ones mentioned by the participants. In this paper, only ten key constructs identified by experts are discussed and the number can be increased by considering experts from different fields and since these constructs are prioritized and ranked according to experts' opinions, it is recommended that objective measures be taken using real data. In addition, the different aspects of social, economic, and environmental sustainability may sometimes be inconsistent, and this study has not fully evaluated this issue. Providing effective solutions to address the challenges presented in the paper can be a topic for future studies. Also, we recommend that researchers should focus on different social media platforms like twitter, Facebook, etc. and examine the impacts of these various media on sustainability.

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