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Impact of Big Data Analytics Capability on the Circular Economy capability of Chinese Manufacturing firms: Mediating Role of Knowledge of, practice of, and commitment to Environmental sustainability orientation

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Abstract: *The purpose of the present research was to examine the influence of big data analytics capability (BDAC) on circular economy capability (CEC) and the mediating role of knowledge of environmental sustainability orientation (ESO), practices of ESO, and commitment to ESO between BDAC and CEC. The study analyzed the BDAC and ESO practices, ESO knowledge, and ESO commitment in terms of their contribution to the development of CEC. The study was performed in the manufacturing sector of China where the data was collected through 350 questionnaires from middle and upper-level managers of selected organizations. The data collected through the questionnaire was analyzed through SPSS and AMOS in which CFA and SEM were mainly performed to check hypotheses. The findings of this study revealed that BDAC has a significant positive influence on the CEC of the firm. It has been further found that the knowledge of ESO, practices of ESO, and commitment to ESO play significant mediating roles between BDAC and ESO. Hence, the BDAC and ESO can positively contribute towards the sustainability goal of firms. These findings are theoretically as well as practically important because they will enhance the sustainability literature. They will help strategy makers as well as policymakers to pursue their sustainability goals through improved BDAC, ESO, and CEC.*

Key Words: *Sustainability; Environmental impact assessment; circular economy capability; big data analytics capability; environmental sustainability orientation.*

1. INTRODUCTION:

Since, globalization and highly competitive modern markets have changed the definition of success for businesses therefore, the most successful businesses are those businesses that can quickly respond to rapid and unpredicted alterations in the market and the world [1,2]. This means that firms need to identify and predict sudden changes in the market and then, they have to respond in an effective manner. This is only possible with a good big data analytics capability (BDAC) through which the responsiveness and performance of the firm can improve. The BDAC refers to the ability of an organization to use data management and aptitude for the enhancement of competitiveness of the business and its supply chain as the BDAC has a potential role in the operational and functional management of an organization [2,3]. It is argued by past researchers that the BDAC enables an organization to accomplish better competitive outcomes because the big data assists the business to highlight sudden changes and then to take proper actions in response to those changes at the right time which contribute to the ultimate success of the business [4,5]. This capability of an organization potentially contributes towards the incorporation of many benefits and positive outcomes for the organization including improved organizational performance, improved sustainability performance, achievement of competitive advantage, and the development of further organizational capabilities [1,3,6]. Among other benefits of BDAC, the need for sustainability performance and achievement of sustainability goals is growing in the modern era because customers have become very likely to view and evaluate the performance of an organization in terms of its sustainability performance.

The growing need for sustainability performance and assessment has attracted many researchers to perform studies in order to understand and explain different determining elements as well as outcomes of sustainability performance [7-11]. Despite growing research on sustainability performance, it is observed by the current researcher that the "circular economy capability" (CEC) of an organization has been somehow ignored in past literature in terms of its contribution to sustainability performance. The CEC refers to the achievement of sustainability goals while ensuring no waste. According to Zeng, et al. [12], "CEC is the general term for implementing the 3R principles (reduction, reuse and recycle) for firms." These principles are applied to enhance all activities of the business with respect to sustainability. According to the definition provided by the Ellen Macarthur Foundation [13], "a circular economy is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles". It means that the ultimate goal of the circular economy is to improve the technical and sustainability performance of interconnected activities of the business [12,14]. Despite the large importance of CEC in sustainability performance, there are very limited studies in the current literature that examined the importance, predictors, and outcomes of CEC in the supply chain of an organization. Therefore, the existing literature seems to provide scarce understanding and empirical evidence about the role, BDAC can play to enhance the CEC in the supply chain of manufacturing organizations. The current paper aims to analyze the influence of BDAC on the CEC of manufacturing organizations along with the mediating role of ESO practice, ESO knowledge, and ESO commitment. The current study draws its arguments from organizational capabilities theory which is an extension of the "Resource-based view". According to this view, rare, valuable, non-substitutable, and matchless resources of an organization enable it to develop a sustainable competitive advantage and achieve other positive outcomes. These resources can enable the firm to differentiate itself from other firms, capitalize on different opportunities, and thus, can improve competitive performance [15-18]. BDAC is also a rare capability of the organization which can provide it with increased opportunities to exploit information and achieve desired results. Based on this theory, the current study proposes that the BDAC enables an organization to develop CEC. When an organization has good BDAC, then it comes in a better position to use its knowledge and information for taking effective measures to improve sustainability performance. In this way, the BDAC can help an organization in the achievement of its holistic sustainability goal. [4,19,20]. Therefore, the current study and its findings tend to support the organizational capabilities theory (OCT). The OCT suggests that an organization can achieve desired outcomes and competitive advantage based on its unique capabilities. Therefore, it is proposed here that the organization's BDAC can help it to achieve the goal of a circular economy and sustainable performance. Among other determinants of CEC, the role of "environmental sustainability orientation" (ESO) is also important because it tends to motivate the organization to adopt such practices and activities in its functions which contribute towards sustainability performance [21,22]. A firm committed to environmental sustainability and aware of environmental sustainability practices the ESO comes in a better position to achieve the goal of a circular economy with the highest utility, minimum waste, and maximum sustainability performance [23]. It means that the commitment to ESO, awareness & knowledge of ESO, and practice of ESO are important factors that can lead the firm to achieve its sustainability goal and circular economy. It is suggested by Danso, et al. [24] that ESO can contribute positively towards performance outcomes and competitive advantage of the organization. When a firm has a good BDAC, then it realizes the importance and concerns of environmental sustainability. In other words, BDAC enables an organization to enhance its orientation toward environmental sustainability which is the ultimate predictor of CEC. However, most of the recent literature on ESO focused on large firms of highly developed countries while its role in the environmental performance of manufacturing firms of moderately developed or developing countries has been ignored to an extent. Therefore, the second objective of the current research is to examine the mediating role of three aspects of ESO (i.e., knowledge of ESO, practices of ESO, and commitment to ESO) between BDAC and CEC of manufacturing organizations. These objectives will enable the current study to overcome the scarcity of the existing literature regarding the linkage of BDAC, CEC, and ESO because the current paper is the first one to analyze these relationships in a combined model. The remaining paper encompasses the review of literature, the methodology adopted, results found, discussion of those results, and conclusion of the study.

2. LITERATURE REVIEW:

Due to the increased globalization, the management and success of businesses have become so challenging because the current business and market conditions including the short life cycle of product, consistent advancements in IT, environmental concerns, and high competition have changed the angle of success for modern businesses [1]. To meet the challenges regarding environmental concerns, firms are looking for effective capabilities and activities through which they can deal with these challenges successfully. CEC is a general term related to the sustainability performance which refers to the capability of a firm to enhance the utility, and to minimize the adverse environmental impact of its business activities. CEC can be defined as the capability of a firm which enables the firm always to be "restorative" and "reformative" by ensuring the highest utility of products, materials, and elements while maintaining the difference between technical and biotic cycles [13]. CEC enables the organization to curtail the use of resources, enhance the efficiency of resources, and curtail the environmental impacts of all practices of business [12,14]. BDAC and ESO are two important factors which play the potential role in the development of CEC of the organization. The environmental sustainability orientation (ESO) is a term which refers to the coordination of the firm to identify and exploit entrepreneurial opportunities in an environmentally and socially responsible way [22,25]. Hence, the commitment to ESO, knowledge of ESO, and practices of ESO can enable the firm to achieve goals of circular economy. The big data analytics capability (BDAC) is defined as the capability of the firm to identify, evaluate, and manage the large and diverse data in order to make informed business decisions. The BDAC becomes more important when it comes to supply chain because the sustainable performance of supply chain can only be ensured by uncovering important information and identifying market trends and customer's needs and preferences which assist the organization to make informed decisions. BDAC is mostly termed as the set of organizational techniques, tools, and processes which makes an organization able to process, identify, visualize, and analyze the data in order to produce insights which ultimately help it in strategic planning, strategy execution and decision making [1,26]. In BDAC, the term analytics has been defined by Grossman and Siegel [27] as "the process that extracts valuable insights from data via creating and distributing reports, building and deploying statistical and data-mining models, exploring and visualizing data, sense-making, and other related techniques." Hence, the BDAC supports an organization to pursue its goals as it brings many positive outcomes for the organization including firm performance, sustainability performance, competitive advantage, improved efficiency, innovation, etc. [3,4,15]. The BDAC is particularly important in the supply chain because it plays an important role in incorporating certain benefits into the supply chain. There are many studies found in the recent literature which discuss the importance of BDAC in the supply chain e.g. [3,19,20]. However, there are a few studies that examined the particular role of BDAC in developing the CEC in the supply chain of an organization.

BDAC and CEC

The organizational capabilities theory (OCT) provides insights into how different organizational capabilities support the organization in achieving its goals and the sustainable competitive advantage. The OCT is an enhancement of the "Resource-based view" (RBV) which provides the idea that the non-imitable, unique, rare, and valuable resources of a firm are sources to achieve sustainable competitive advantage. In OCT, it is suggested that the internal capabilities of the firm are the source to achieve organizational goals and unique competitive advantage because these internal capabilities vary from one organization to another organization so, they make organizations different from one another [17,18]. These internal capabilities ultimately determine the strengths of a firm which are important sources of competitive advantage. Therefore, it is proposed here that the organizational capability related to big data analysis can help the firm to accomplish the desired goal of a circular economy and sustainable performance. Chaudhry, Aftab, Arif, Tariq and Roomi [17] also suggested that OCT supports the linkage between an organizational capability and the performance of the firm. Among other capabilities, the BDAC is a key organizational capability that is about the ability of a firm to identify, process, manage, and evaluate the data in order to make informed business decisions. The debate over the role of BDAC in pursuing organizational strategic goals is increasing because there is no harmonized insight about the way BDAC can support them [1,4,28-31]. The BDAC in the supply chain of a business enables it to develop CEC because it supports it to utilize data and information in the best way for the sake of achieving sustainability goals. The BDAC makes an organization able to evaluate alternatives linked to supply and demand suspicions [32]. It is suggested by Choi, et al. [33] that big data plays a significant role in operation management because it significantly affects the operation management practices of a business. The research work of Gunasekaran, Papadopoulos, Dubey, Wamba, Childe, Hazen, and Akter [3] revealed that the BDA can significantly promote the performance of the organization and supply chain. It was suggested by them that disruptions in the supply chain negatively affect performance while better competitive outcomes can be achieved with the aid of BDA. Similarly, Dubey, Gunasekaran, and Childe [1] also argued that the BDAC helps an organization promote its supply chain agility. They further suggested that the BDAC helps an organization pursue its strategic goals and gain a competitive advantage. Srinivasan and Swink [26] also suggested that the role of BDA in the operational decisions of the supply chain is also of great importance in addition to its role in identifying the customers' intentions and behaviors. Frisk and Bannister [34] also highlighted the positive role of BDA in decision-making and suggested that the BDA supports an organization to make informed decisions. The development of CEC requires the proper understanding of market trends, customers' preferences, business processes, and environmental concerns so that, sustainability goals can be pursued by ensuring no waste. In this regard, BDAC supports an organization to identify and highlight wastes in different business processes so, the

organization comes in a better position to make informed decisions in order to reduce waste and to build CEC in the supply chain. Some other past studies also provide supportive arguments related to this association e.g. [12,14,35-39]. Therefore, the first hypothesis of the current research is:
H1: "Big data analytics capability has a significant positive impact on the circular economy capability of the supply chain of the firm"

Role of ESO between BDAC and CEC

The ESO refers to the tendency of a firm to pursue its entrepreneurial and business activities in a socially and ecologically responsible manner because ESO is always followed by the improved ability of the firm to act and react in a socially and ecologically responsible way [25,40]. Firms with higher ESO are more likely to integrate environmental aspects into their strategic decisions so, they are more likely to behave in an ecologically responsible manner. It means that the integration of environmental concerns into strategic decisions is one of the most needed factors of ESO. Although there are some key studies found in the literature regarding ESO e.g. [21,22,24] However, the particular literature regarding the role of ESO in developing the CEC in the supply chain seems to be limited therefore, there is a need to highlight and explain the role of different aspects of ESO (e.g. knowledge of ESO, practices of ESO, and commitment to ESO) in the development of CEC in the supply chain of an organization. It is proposed here that the knowledge of, practices of, and commitment to the ESO mediate the association between BDAC and CEC. BDAC can significantly enhance the knowledge, practices, and commitment regarding sustainability through better processing, understanding, and analysis of big data. ESO ultimately enhances the capability of the firm to act in an environmentally responsible manner. An organization having a good BDAC is better able to understand and analyze the environmental concerns, and the need for environmental commitment as well as orientation. It means that BDAC contributes to the ESO which ultimately enables the firm to accomplish the goal of circular economy. Danso, Adomako, Amankwah-Amoah, Owusu-Agyei, and Konadu [24] argued that the ESO can positively influence the performance outcomes of an organization because firms with ESO tend to outperform firms without ESO.

Dubey, et al. [41] suggested that BDA supports an organization to pursue its sustainability goal by improving its environmental sustainability practices. Firms who are oriented towards improving their sustainability performance are more likely to develop CEC due to having great knowledge of ESO, applying improved ESO practices, and increasing commitment to ESO which are largely contributed by BDAC. Since the BDAC enhances the ability of the firm to make informed decisions based on extensive useful information, therefore, it tends to enhance the practice and knowledge of ESO which ultimately enhance the CEC. Roxas, Ashill, and Chadee [22] also highlighted the supportive role of ESO in the performance of small businesses by conducting a study in the Philippines. They suggested that ESO enhances the firm performance. The research work by Amankwah-Amoah, Danso, and Adomako [21] also supported the positive role of ESO in the performance of a firm. However, the literature about the role of ESO knowledge, ESO practice, and ESO practice in building CEC seems to be silent. Therefore, the next hypotheses of the current study are:
H2: "Knowledge of ESO has a significant mediating role between BDAC and CEC"
H3: "Practice of ESO has a significant mediating role between BDAC and CEC"
H4: "Commitment to ESO has a significant mediating role between BDAC and CEC".

Figure 1 provides the framework of the current study revealing all proposed relationships.

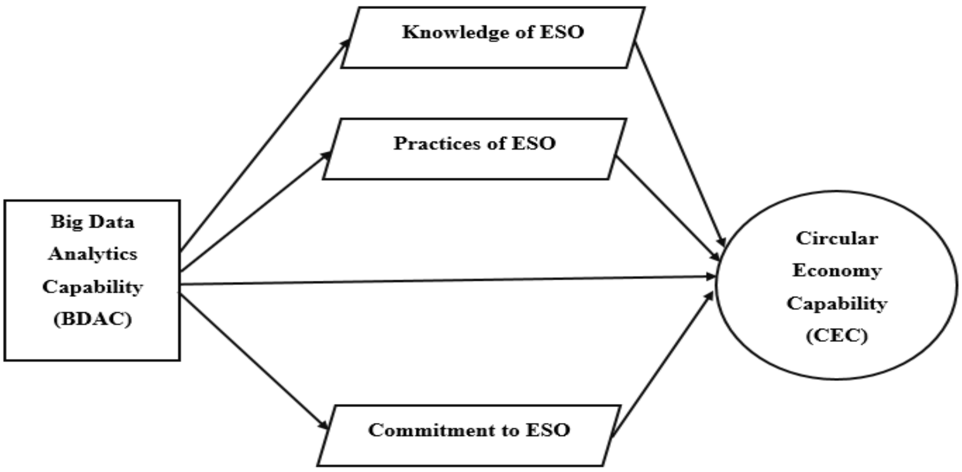

Figure 1. *Framework of Study.*

3. MATERIALS AND METHODS:

Research Design, Population, Sampling and data collection

The present research has been completed with a cross-sectional time horizon, deductive approach, and methodological assumptions of positivism. The quantitative research method was adopted to collect the data and perform the research because the current study is explanatory research that analyzed and enhanced an already existing phenomenon. The current study has been performed on the manufacturing sector of China and the data was collected from upper and middle-level managers of selected manufacturing organizations through a structured questionnaire. The lower-level managers were not selected as participants of this study because they do not seem to be able to provide authentic and accurate responses about the BDAC, ESO, and CEC of the firm. Middle-level and upper-level managers are better aware of environmental strategies, environmental practices, and the sustainability performance of the firm. Therefore, they were regarded as suitable participants for the current study. The rationale for selecting the manufacturing sector to analyze the relationship among BDAC, ESO, and CEC lies in the fact that manufacturing firms mostly have to go through such activities and processes which can really challenge environmental concerns therefore, there is a need to analyze the phenomenon through which manufacturing firms can build circular economy capability by enhancing their BDAC, knowledge of ESO, practice of ESO, and commitment to ESO. Therefore, the population of the study consists of manufacturing firms in China. The purposive sampling technique was used to decide the sample of the study because the purpose was to check the role of BDAC and ESO in building CEC among manufacturing firms so, upper and middle-level managers of manufacturing firms could provide the appropriate data for this purpose. The quantitative research design was adopted for the current study in which the survey strategy was adopted for the data collection. A questionnaire-based survey of manufacturing firms in China was conducted for which, the questionnaire was adopted from previous studies. Since the current study was completed by applying structural equation modeling to the data so, the sample size needed to be appropriate for SEM. Hair, et al. [42] and Hair, et al. [43] discussed that the "ten times rule" is an appropriate approach to select the sample size for SEM. Therefore, the formula of number of items*10 was used to select the sample size. Since there were 32 items in the questionnaire so the sample size must be 320 at minimum. Therefore, 350 questionnaires were distributed among participants through email. To collect data from selected participants, a questionnaire-based survey was conducted in the manufacturing sector of China. The questionnaire was structured by adopting measures of each variable from past studies. Questionnaires were administered by self by researchers of the study and ethical considerations were maintained throughout the data collection procedure.

The validity, Reliability, and Common Bias

To confirm the validity and reliability, SPSS and AMOS were used in which Cronbach's α for all five variables was ensured to be larger than 0.7. The validity was checked through AMOS in which the discriminant as well as convergent validity was confirmed for the data. The common bias issue was checked and controlled through the method of Donaldson and Grant-Vallone [44] and Donaldson and Grant-Vallone [44]. The "Harman's single factor test" was used to confirm that there is no issue of common bias in the study and so, the risk of common method bias was eliminated.

Measures

The current study included five key variables among which one is the dependent variable, one is the independent variable and three are mediators. The questionnaire for the current study was designed by adopting the scales of previous studies. The BDAC was measured by adopting the five items scale from the study of Dubey, Gunasekaran, and Childe [1]. The CEC was measured by adopting the ten-item scale from the study of Zeng, Chen, Xiao, and Zhou [12]. The knowledge of ESO has been measured through 5 items adopted from the study of Danso, Adomako, Amankwah-Amoah, Owusu-Agyei, and Konadu [24], the practice of ESO has been measured using 8 items adopted from Danso, Adomako, Amankwah-Amoah, Owusu-Agyei and Konadu [24], and the commitment to ESO has been measured using 4 items adopted from the study of Danso, Adomako, Amankwah-Amoah, Owusu-Agyei and Konadu [24]. Through these adopted scales, the questionnaire was structured in which the respondent rated his/her answer on the Five-Point Likert scale. These questionnaires were sent to upper-level managers and middle-level managers of manufacturing organizations in China through E-mail after getting informed consent.

Hypothesis Testing

The data collected from middle and upper-level managers of manufacturing firms in China were analyzed in SPSS and AMOS in which confirmatory factor analysis (CFA) and structural equation modeling (SEM) were performed to check relationships. The CFA was applied to check the model fitness and SEM was applied to assess the relationships.

The impacts of BDAC on CEC and mediating effects of knowledge of, commitment to, and practice of ESO between BDAC and CEC were assessed through SEM. Through SEM, direct as well as indirect effects were estimated between variables so, hypotheses were tested based on SEM results. To validate the hypotheses, the level of significance was used as a key criterion because the effects with p-value <0.05 were considered to be significant while effects with p-value >0.05 were regarded as non-significant. It means that the hypotheses were validated based on the significance of those hypotheses.

Results

The questionnaires were distributed among 350 participants in the manufacturing sector of China. Total responses received back from participants were 320 out of which 303 responses were valid to be considered for analysis. Therefore, the current analysis has been performed on 303 responses. Out of 303 responses, 125 were filled by male respondents while 178 were filled by female respondents. There were 48.8 percent of respondents in the sample who were post-graduated and 40.3 percent of respondents were holding Master's degrees. There were only 7.6 percent of responses that were filled by graduated participants while participants with other educational qualifications were only 3.3 percent of total responses. The age of 82.5 percent of respondents was ranging from 21 to 30 years and 13.9 percent of respondents reported their age ranging from 31 to 40 years. There were only 3 percent of respondents in the study who were of age between 41 and 50 years while respondents with age more than 50 years were only 0.7% of the total respondents. Hence, most of the respondents of the current study were females, post-graduated, and of age ranging from 21 to 30 years.

Descriptive Statistics

The descriptive analysis was performed to check the normality, appropriateness, and acceptability of the data of all five variables of the study (see Table 1). Based on the mean value, standard deviation, and skewness, the normality of the data was confirmed.

Table 1. Descriptive Statistics.

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
CEC	303	1.00	5.00	3.5765	1.08208	-.855	.140
BDAC	303	1.00	5.00	3.5439	1.13120	-.745	.140
KESO	303	1.00	5.00	3.5881	1.08664	-.837	.140
CESO	303	1.00	5.00	3.4101	1.05869	-.272	.140
PESO	303	1.00	5.00	3.4538	1.11870	-.567	.140

The mean value of CEC, BDAC, KESO, CESO, and PESO are all falling within the acceptable range i.e., 1-5 which was the rating scale of these variables in the questionnaire. The standard deviations of these variables are also showing that there is not too much variation in the data of these variables. It means that there is no outlier found in the data of CEC, BDAC, KESO, CESO, and PESO. The normality of the current data has been further proved by statistics of skewness which is not less than -1 and not more than +1 for any of the current variables. All statistics of skewness are ranging from -1 to +1 so, the current data is normal and can be used for further analysis. Moreover, the suitability of the data has also been proved through "KMO and Bartlett's test" (see Table 2).

Table 2. KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.947
Bartlett's Test of Sphericity	Approx. Chi-Square	11262.048
	df	496
	Sig.	.000

The KMO for the present data is 0.947 (i.e., greater than 0.6) and the p-value of this test is <0.05 so, the current data is suitable.

Reliability, Convergent validity, and Discriminant validity

The reliability and validity of the current data were checked through key indicators of CR, AVE, MSV, and square root of AVE. The internal consistency of the data was checked to confirm the convergent validity while the multicollinearity was checked to confirm the discriminant validity of the data (see Table 3).

Table 3. Convergent Validity and Discriminant Validity.

	CR	AVE	MSV	MaxR(H)	CESO	BDAC	KESO	PESO	CEC
CESO	0.900	0.692	0.484	0.902	**0.832**				
BDAC	0.951	0.797	0.379	0.967	0.387	**0.893**			
KESO	0.943	0.768	0.379	0.979	0.444	0.616	**0.877**		
PESO	0.927	0.788	0.484	0.988	0.696	0.382	0.441	**0.887**	
CEC	0.918	0.751	0.341	0.991	0.574	0.584	0.527	0.503	**0.867**

The CR for all variables i.e., CEC, BDAC, KESO, CESO, and PESO is greater than 0.7, and AVE for all of them is greater than 0.5 (showing the average variance extracted of that particular variable more than 50%) while MSV against all of them is smaller than respective AVE. It means that the convergent validity of the data has been proved through these indicators. The discriminant validity of the data of all these variables can also be proved by looking at correlations of all these variables which are showing that CEC, BDAC, KESO, CESO, and PESO all have the highest correlations with themselves as compared to their correlations with one another. Therefore, it can be concluded that there exists convergent as well as discriminant validity in the current data.

Model Fitness

The model fitness refers to the degree to which the observed data fits with the hypothesized relationships. It means that the model fitness determines the ability of the hypothesized model to represent the observed data [45,46]. The model fitness was checked through "confirmatory factor analysis" (CFA) The current model containing CEC, BDAC, KESO, CESO, and PESO was assessed in terms of its fitness by running CFA in AMOS (see Table 4).

Table 4. CFA.

Indicators	Current values
CMIN/DF	2.340
GFI	.822
CFI	.946
IFI	.946
RMSEA	.067

It has been found through the current analysis that all key indicators of model fitness (i.e., CMIN/DF, GFI, IFI, CFI, and RMSEA) are giving acceptable values for the current model. The threshold for these indicators suggests that the CMIN/DF must be less than or equal to 3, GFI must be equal or greater than .80, IFI and CFI must be equal or greater than .90, and RMSEA must be less than or equal to .08 [9]. The CMIN/DF<3, GFI>0.80, CFI and IFI >0.90, and RMSEA < 0.08 for the current study are indicating that the model fitness has been proved. Therefore, it can be concluded that the current model containing CEC, BDAC, KESO, CESO, and PESO as key variables has a good fit. Figure 2 presents the CFA performed in AMOS.

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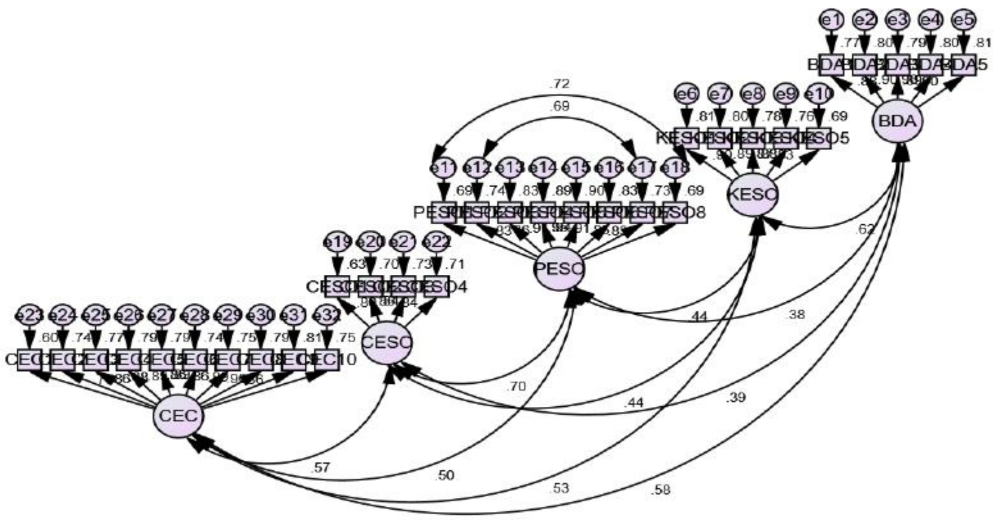

Figure 2. Confirmatory Factor Analysis of variables.

Structural Equation Modeling (SEM)

The hypotheses of the current study were tested by performing SEM in AMOS which produced the results given in Table 5.

Table 5. SEM Results.

Total Effect	BDAC	CESO	PESO	KESO
CESO	.362***	.000	.000	.000
PESO	.371**	.000	.000	.000
KESO	.589***	.000	.000	.000
CEC	.590***	.282***	.131**	.141**
Direct Effect	**BDAC**	**CESO**	**PESO**	**KESO**
CESO	.362***	.000	.000	.000
PESO	.371***	.000	.000	.000
KESO	.589***	.000	.000	.000
CEC	.357***	.282***	.131**	.141**
Indirect Effect	**BDAC**	**CESO**	**PESO**	**KESO**
CESO	.000	.000	.000	.000
PESO	.000	.000	.000	.000
KESO	.000	.000	.000	.000
CEC	.233***	.000	.000	.000

Note: *** indicates p-value <0.001, ** indicates p-value<0.01, * indicates p-value <0.05.

The direct as well as indirect effects of variables produced through SEM are clearly showing that all proposed effects have been significantly proved through results. It is indicated in Table 5 that BDAC has a significant positive impact on CEC because the one-unit increase in BDAC caused a 59 percent increase in the CEC of the firm. However, the direct impact of BDAC on CEC is not equal to the total effect of BDAC on CEC which means that there is some indirect effect of BDAC on CEC which has been caused by mediating variables of this study i.e., knowledge of ESO, practice of ESO, and commitment to ESO. It is found through Table 5 that BDAC significantly and positively affects KESO, CESO, and PESO which ultimately influence the CEC of the firm. It means the mediation of KESO, CESO, and PESO between BDAC and CEC has also been proved. Figure 3 presents these effects through SEM performed on AMOS.

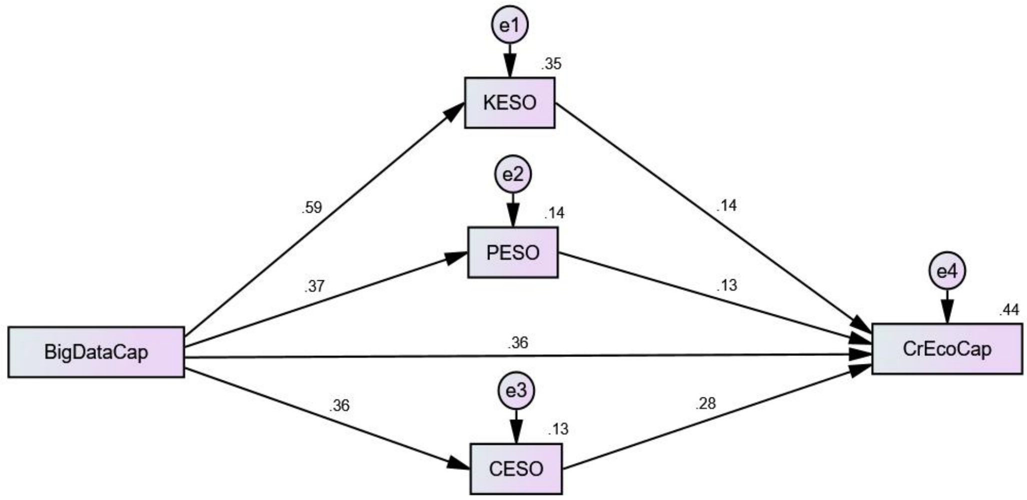

Figure 3. Structural Equation Modeling.

4. DISCUSSION:

The current study was about the impact of BDAC on the CEC of the firm along with mediating roles of knowledge of ESO, practices of ESO, and commitment to ESO between BDAC and CEC. The hypotheses proposed in the current study were tested by collecting quantitative data from the manufacturing sector of China. The data collected was put into analysis through which the significance against these hypotheses was used to make the decision about the acceptance and rejection of hypotheses. In response to the first hypothesis of the study about the impact of BDAC on the CEC, the current study found that there is a significant positive effect of BDAC on CEC. Based on current findings, it is suggested that the increase in BDAC enhances the CEC of firms. It means that the first hypothesis of the current study is accepted. The current empirical analysis revealed that advancements in technologies have allowed firms to enhance their capability to collect, process, and analyze data. For example, supply chain connectivity, mobile technology, data virtualization, stream analytics, data integration, predictive analytics, and other big data technologies have made the process of data acquisition, processing, and analysis by firms faster. These technologies have allowed firms to capitalize on their BDAC for the sake of enhancing their sustainability performance. Some common indicators which firms have used to assess their sustainability performance are “waste output, greenhouse gas emission, water consumption, etc.

The results of the first hypothesis are supported by OCT which supports the idea that organizational capabilities promote competitive advantage, performance, and other abilities of the firm [4,17,18]. These current findings also get theoretical support from the research work of Dubey, Gunasekaran, and Childe [1] who suggested that BDA promotes the performance and other positive outcomes of a firm. These findings are also consistent with some other key previous research for instance, Waller and Fawcett [32], Choi, Wallace and Wang [33], Gunasekaran, Papadopoulos, Dubey, Wamba, Childe, Hazen, and Akter [3], Srinivasan and Swink [26], Frisk and Bannister [34], Nobre and Tavares [38], Jabbour, de Sousa Jabbour, Sarkis and Godinho Filho [39], Tseng, Tan, Chiu, Chien, and Kuo [37], and Zeng, Chen, Xiao and Zhou [12] also supported the positive role of BDA in the improved decision making, strategic performance, organizational performance, CEC, sustainability performance, and other positive organizational outcomes. Therefore, based on current findings and discussion, it can be suggested that BDAC of manufacturing firms supports them to build CEC so, they can achieve sustainability goals in an effective way.

The second, third, and fourth hypotheses of the current research were about the mediating role of knowledge of ESO, practice of ESO, and commitment to ESO between BDAC and CEC. All these three hypotheses have also been supported through current findings because it has been found in the current study that improved BDAC of a firm enables it to get more knowledge of ESO, improved practice of ESO, and high commitment to ESO which are ultimate predictors of CEC so, they play significant mediating roles between BDAC and CEC. These results are also aligned with previous findings in the literature e.g. [21,22,24,25,41]. These studies also supported the positive role of ESO in the achievement of sustainability goals. Therefore, it can be suggested here that the knowledge of ESO, practices of ESO, and commitment to ESO have significant roles in the attainment of sustainability goals and the development of CEC, and these aspects of ESO are significantly nourished by BDAC. All findings of the current study are in line with the existing literature so, the current study is aligned with past studies.

5. CONCLUSIONS :

The current study examined the impact of BDAC on the CEC with mediating roles of knowledge of ESO, commitment to ESO, and practices of ESO. The current study conducted in the manufacturing sector of China through a questionnaire-based survey revealed that the BDAC builds the CEC of the firm. BDAC enables the firm to make informed and improved decisions regarding sustainability performance. Hence, it enhances the capability of the firm to perform its entrepreneurial functions with no waste. Furthermore, it has been found in the current study that the knowledge of, commitment to, and practices of ESO play significant mediating roles between BDAC and CEC. The improved BDAC of the firm enables it to increase its commitment to ESO, knowledge of ESO, and practice of ESO which ultimately supports the sustainability goal of the firm by enhancing the CEC of the firm.

There are significant theoretical as well as practical implications of the current research because it is providing new meaningful insights into the literature of sustainability i.e., the role of BDAC and ESO in building CEC of firms, particularly in moderately developed or developing countries. The current study and findings are expected to contribute to the literature as well as the practice of sustainability because literature and theories regarding the role of BDAC in the improvement of sustainability performance and capabilities will be enhanced. The literature about OCT and the relationship of BDAC with sustainability orientation and CEC will be significantly improved through the empirical findings of the current study. There is a lack of empirical studies regarding the role of BDAC and ESO in the development of CEC particularly in the context of moderately developed and developing countries. Therefore, the current study entails great theoretical and practical importance and relevance due to its novelty and empirical evidence.

Practically, the current study is relevant to the sustainability performance of manufacturing firms which can get important benefits from the findings of the current study. The strategy makers of manufacturing organizations in China will come to know through current findings that how they can build CEC by improving their BDAC and ESO. In this way, they can pursue their sustainability goal. However, firms may face some challenges while achieving CEC through BDAC e.g., lack of technical staff, validation of the data, security of the data, organizational resistance to the big data analytics, etc. In this regard, large firms are more likely to get the advantage of BDAC for achieving CEC as compared to small firms due to having improved infrastructure, skilled staff, and rich resources. Firms should cope with these challenges effectively while struggling for CEC through BDAC.

The policymakers of China will also find the current study very beneficial in understanding the role of big data in sustainability so, they can develop their policies regarding sustainability in accordance with the current suggestions.

In addition to pertinent contributions, there are some limitations of the current study as well. It is limited to the manufacturing sector of China while the BDAC in another sector may not necessarily have the same outcomes. Therefore, future researchers should enhance these findings by conducting cross-sector studies to assess these relationships. Furthermore, the current study has been performed in China while the policies and practices of sustainability may differ from country to country therefore, future researchers can conduct cross-national studies to assess the role of BDAC in CEC, KESO, PESO, and CESO. Furthermore, they should examine the ESO in relation to the low-cost strategy or differentiation strategy of firms in these relationships so that, the overall model can be further improved.

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