Development of a business model in industry 4.0 to achieve sustainable supply chain innovation: Study of Large and Medium Moroccan companies

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Abstract
Moroccan industrial companies are leading many changes inside their supply chain to take advantage of industry 4.0 transformation. This optic aims to ensure sustainability and innovation simultaneously. Or, one of the most crucial operations is to enhance innovation inside supply chain processes and to improve supply chain resilience and sustainability regarding the changeable environment. Therefore, in this paper, we develop an integral business model considering six constructs: supply chain integration, supply chain orientation, competition capability, business continuity management, environmental sustainability, and finally human and social approach. Then we apply the business model to the case of large and medium Moroccan companies. The main objective is to study the impact of the considered constructs with the mediation of industry 4.0 technological systems in achieving supply chain innovation and sustainability. Our paper is built of four sections, the first lists previous studies performed in some countries, the second presents the proposed business model, the third describes the experimental data collection, and in the last part, we discuss the results of the data validation process, followed by a conclusion and work perspectives.

Keywords
Industry 4.0 technologies, Digital transformation, Business model, Innovation, Sustainability.

1. Introduction
In the age of Industry 4.0, the Moroccan manufacturing sector is becoming a dynamic changing field due to the international permanent flow of inventions and technological progress. Moroccan authorities have also put forward an ambitious industrial acceleration strategy giving new impulses to the field: policies review enhancing infrastructure-related public-private-partnerships, high way network and maritime infrastructure modernization, free zones creation in many cities, special academic and professional programs more adapted to Moroccan manufacturing cooperates needs. Despite those structural reforms and strategic investments as part of the industrial acceleration plan launched in 2014 by the Moroccan government, this transformation generated a moderate gain to the country. According to IMF Bank data, the gross domestic product (GDP) showed a slow positive trend moving from 101.18 B.USD by 2015 up to 119.7 B.USD by 2019 (World Bank Group). The manufacturing field generated by 2015 a

value-added of 26.402 B.USD. This value-added reached 30.338 B.USD by 2019. The same source confirmed a flat trend for social and environmental indicators. In this sense, it appears necessary to develop an integrated business model for the Moroccan industrial field, which can first highlight the relation between innovation and sustainability through the mediation of Industry 4.0, and then determine constructs that lead to achieve a sustainable supply chain innovation.

2. Literature Review

The concept of sustainable supply chain innovation SSCI which is our basic function in this research, is combining sustainable supply chain management SSCM and sustainable innovation SI. For this reason, we performed a digression to the historical understanding of these two concepts.

SSCM is defined as the process of controlling and managing information, material, and capital flow and the cooperation among firms along the supply chain. It is taking into consideration the triple-bottom-line dimensions derived from customer and stakeholder requirements (i.e. economic, social, and environmental) (K. Xu and H. Cong 2012). Many studies have highlighted the importance and benefits of sustainable supply chain management (SSCM) regarding the performance of the firms (Giovanna Culot et al. 2020, Ramesh Krishnan et al. 2021, Qingchun Meng et al. 2021, Rakesh D. Raut et al. 2021). In fact, SSCM helps to reduce the negative supply chain operations impacts and improves the organization's efficiency from social, economic, and environmental perspectives. SSCM initiatives provide a means for firms to achieve a "win-win-win" sustainable outcome (Himanshu Guptacite 2020, Wong and Tseng 2014).

Regarding the concept of sustainable innovation, it derives from eco-innovation, environmental/green innovation, and social innovation, and builds on all dimensions of sustainable development (Fredrik Nilsson et al. 2021, Muhammad Fawad Afraz et al.2021, Chitra Lekha Karmaker et al. 2021). Cultural necessity, temporal as well as spatial aspects, are intrinsic in sustainable innovation (Cimini C. et al. 2019, Daiane Mülling Neutzling et al.2018). Sustainable innovation seeks to minimize socio-environmental impact while increasing the triple-bottom-line.

For models proposed in recent years, the authors Abudaqa et al. (2020) explored one of the relevant business models in a study conducted in Abu Dhabi for PME companies to achieve supply chain innovation, within the mediation capacity of intelligent information systems. In this regard, they considered three constructs: supply chain integration, supply chain orientation, and competition capability (Fredrik Nilsson 2021, Abudaqa et al. 2020). Another relevant model is explored in a study conducted in the South African context, including new dimensions' constructs relating to: Human enablers, and Institutional environment (B. Surajit and A. Telukdarie 2018). However, and to the best of our knowledge, no study has developed a business model in the Moroccan context, while considering innovation and sustainability simultaneously.

Therefore, in this paper, we developed a model covering the tree constructs included in the first model, three other constructs are added to this model to over sustainability social and environment approaches. We define SSCI as innovations realized in a supply chain context that explicitly covers: Supply chain integration, supply chain orientation, competition capability, business continuity management, Environment sustainability, and finally human and social approach. And finally, we apply the business model to the case of large and medium Moroccan companies.

3. Theoretical model

Sustainable innovation is defined as "the introduction of products, production processes, management practices, or business models, new or significantly improved, that bring economic, social and environmental outcomes" (Fredrik Nilsson et al 2021, Niels Robert Schneider2020).

In this model we consider that sustainable supply chain innovation SSCI requires two sub-functions who are supply chain innovation and supply chain sustainability. The objective of the exploratory study is to find the optimal business model for sustainable supply chain innovation in the Moroccan industrial field considering the importance of the proposed constructs along with the mediation role of Industry 4.0 technological systems.

In Fig. 1 are presented variables, constructs, and optimized functions. It also presents the following relations: the relation between constructs and their variables, the relation of innovative supply chain (ISC) and sustainable supply chain (SSC) with sustainable supply chain innovation (SSCI), the relation of the six constructs with ISC and SSC and the relation presenting the mediation role of industry 4.0 technological systems with ISC and SSC

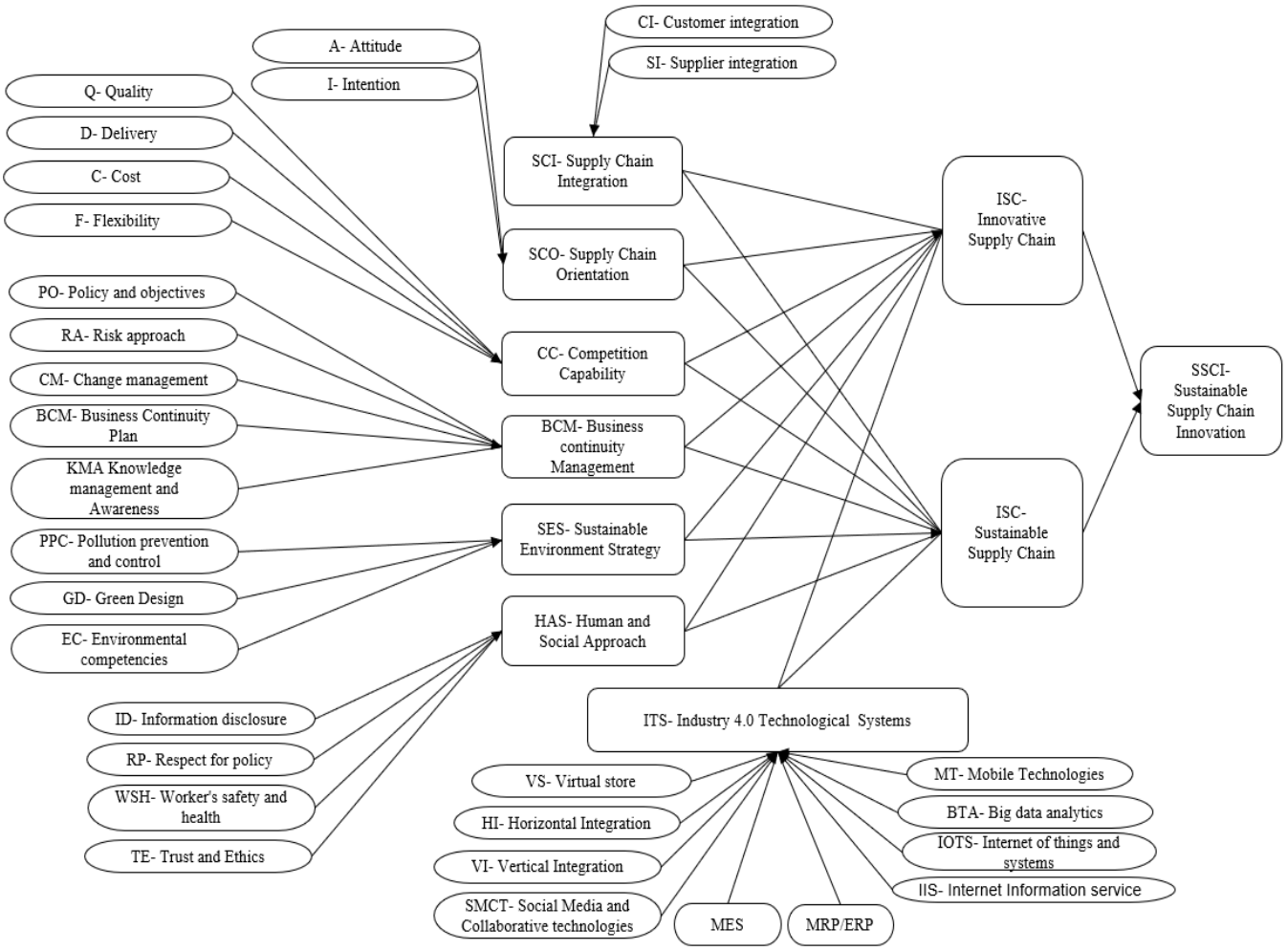

Fig. 1. Theoretical mode

It is crucial to provide definitions from literature and technical sources for some important notions building the theoretical business model of this study. In this context, the Table. 1 contains some definitions for important contracts along with their working dimensions and references.

Construct	Theoretical or nominal definitions	Article References
Sustainable supply chain innovation	"Innovations realized in an SC context that explicitly covers all three pillars environmental, social, and financial) of sustainable development, while SIs are defined as innovations realized in a company context that explicitly covers all three pillars of sustainable development."	Fredrik Nilsson and Malin Goransson (2021)
Supply chain integration	"A process supporting the integration of all the relevant parties of the supply chain, like the customer and supplier, with the motive of working effectively to achieve the common goals, is considered supply chain integration."	Adebanjo et al. (2018); A. Abudaqa et al. (2020)
Supply chain innovation	"A radical/incremental change within the process, technology or network of a supply chain, individually or collectively, that happens in the relevant industry, company or supply chain, and aims to boost the process of stakeholder's value creation."	(Arlbjørn, de Haas, & Munksgaard, 2011) ; A. Abudaqa et al. (2020)
Supply chain orientation	"A strategic, systematic, attitudinal, intentional implication of the processes and activities required to manage the supply chain flow are considered as supply chain orientation."	Jadhav et al. (2019) ; A. Abudaqa et al. (2020)

Competition capability	"A firm's real performance as compared to the market competitors based on cost, quality, delivery, and flexibility is considered competition capability."	Ho et al. (2016) ; A. Abudaqa et al. (2020)
Business continuity management	The Business Continuity Institute (Business Continuity Institute 2007b) defines Business Continuity Management (BCM) as an act of anticipating incidents that will affect mission-critical functions and processes for the organization and ensuring that it responds to any incident in a planned and rehearsed manner.	Leni Sagita et al. (2017)
Sustainable environment strategy	A strategy basing on the meeting of the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them, …and more specifically, as a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity.	John Morelli (2011)
Human and social approach	Industrial activities have given rise to global environmental impacts and damage to human life. This rising negative global environmental issues has forced many stakeholder groups including policy experts and environmental activists to advocate for a more and increasingly tougher governmental regulations.	(Khan et al., 2018).
Industry 4.0 technological systems	"A comprehensive terminology and concept for the fully automated production. In the modular Smart Factories of Industry 4.0, various Cyber- Physical System (CPS) processes can be monitored through virtual mapping and decentralized decisions of real operations. Real-time communication and collaboration can take place between people and machines or between either them. Over the Internet of Things (IoT), internal and external organizational services can be provided and accessed."	(Daniel Kozma, Csaba Hegedus, Pal Varga, 2019)

Table 1: Definition for optimized function, main constructs and mediator

4. Experimental data collection

The study focused on Moroccan manufacturing companies including multinational companies, Moroccan listed companies, and SMEs, main sectors are contained in the study for example Semiconductors, automotive, aeronautic, agro, and others. The study is performed based on experts' and managers' feedback regarding internal digitalization strategy, innovation strategy, and sustainability in the supply chain. The study uses an exploratory approach based on primary data collection techniques. The questionnaire used in online format includes three sections, the first part is the demographic section, which contains information on gender, academic level, role inside the company, and years of experience, the second section contains information related to firms like number of employees in the firm, activity, annual revenues. The last one is dedicated to questions and items related to the model study. Around 120 online questionnaires were emailed, and more than 100 mails were sent on LinkedIn to managerial personnel working in the sampled companies. A total of 102 responses were received, of which 99 were considered accurate for data analysis. Each construct is measured basing on Likert scale where the respondent must select an answer according to his agreement: from 1/5 strongly disagree to 5/5 which means strongly agree.

The Table. 2 gives details of the constructs and specify their dimensions and important items for our business model. Then the model is validated using SPSS and SmartPLS software.

N°	Type	Construct	Abbrev.	Dimensions	Items						
1	DV1	Innovative Supply Chain	ISC		ISC1	ISC2	ISC3	ISC4	ISC5	ISC6	ISC7
2	DV2	Sustainable Supply Chain	SSC		SSC1	SSC2	SSC3	SSC4			
3	DV3	Sustainable Supply Chain Innovation	SSCI		SSCI1	SSCI2	SSCI3				
4	IV1	Supply Chain Integration	SCI	Customer Intergration	CI1	CI2	CI3	CI4	CI5		
				Supplier intergration	SI1	SI2	SI3	SI4	SI5		
					SCI1	SCI2					
5	IV2	Supply Chain Orientation	SCO	Attitude	A1	A2	A3	A4			
				Intention	I2	I3	I4				
					SCO1	SCO2					
6	IV3	Competition Capability: Value generation business model	CC	Flexibility	F1	F2	F3				
				Delivery	D1	D2	D3	D4			
				Cost	C1	C2	C3	C4			
				Quality	Q1	Q2	Q3	Q4			
					CC1	CC2					
7	IV4	Business Continuity Management	BCM	Policy and objectives	P1	P2	P3	P4			
				Risk Approach	RA1	RA2	RA3	RA4			
				Change management	CM1	CM2	CM3	CM4	CM5		
				Business Continuity Plan	BCP1	BCP2	BCP3	BCP4	BCP5	BCP6	
				Knowledge management and Awareness	KM1	KM2	KM3	KM4			
					BCM1	BCM2					
8	IV5	Sustainable Environment Strategy	SES	Pollution prevention and control	PPC1	PPC2	PPC3				
				Green Design	GD1	GD2	GD3				
				Environmental competencies	EC1	EC2	EC3				
					SES1	SES2	SES3				
9	IV6	Human Social Approach	HSA	Information disclosure	ID1	ID2	ID3				
				Respect for policy	RP1	RP2	RP3				
				Worker's safety and health	WSH1	WSH2	WSH3	WSH4			
				Trust and Ethics	TE1	TE2	TE3				
					HSA1	HSA2					
10	Mediator	Industry 4.0 Technological Systems	ITS	Digital Strategy	DS1	DS2	DS3				
				Social Media and Collaborative technologies	SMCT1	SMCT2	SMCT3				
				Mobile Technologies	MT1	MT2	MT3				
				Big data analysis	BDA1	BDA2	BDA3				
				Cloud Computing Services	CCS1	CCS2	CCS3				
				Horizontal Integration	HI1	HI2	HI3				
				Vertical Integration	VI1	VI2	VI3				
				Internet of things and Systems	IOTS1	IOTS2	IOTS3				
				ERP/MRP	EMRP1	EMRP2	EMRP3				
				MES	MES1	MES2	MES3				
				Virtual store	VS1	VS2	VS3				
					ITS1	ITS2	ITS3				

Table 2: Variables and dimensions of the business model

5. Results and Discussion

5.1 Descriptive statistics and Factor model

Initial data analysis as aligned to the first and the second parts of the questionnaire is conducted on the various aspects of the sample. Those parts detail some aspects related to demographic criteria of respondents and firms in Fig. 2. The

data are analyzed using SPSS software (for descriptive analysis). Some of the results of this analysis are presenting in Fig. 2.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	12	12,1	12,1	12,1
	Gender	1	1,0	1,0	13,1
	Male	86	86,9	86,9	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	22 to 27	2	2,0	2,0	2,0
	28 to 35	52	52,5	52,5	54,5
	36 to 44	14	14,1	14,1	68,7
	45 to 52	10	10,1	10,1	78,8
	53 to 59	16	16,2	16,2	94,9
	60 or Older	4	4,0	4,0	99,0
	Age	1	1,0	1,0	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0- 2 years	2	2,0	2,0	2,0
	11-20 years	26	26,3	26,3	28,3
	3- 5 years	22	22,2	22,2	50,5
	6-10 years	28	28,3	28,3	78,8
	Exp	1	1,0	1,0	79,8
	More than 21 years	20	20,2	20,2	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - 100	12	12,1	12,1	12,1
	1,001- 5,000	12	12,1	12,1	24,2
	10,001- 100,000	19	19,2	19,2	43,4
	101- 500	14	14,1	14,1	57,6
	5,001- 10,000	14	14,1	14,1	71,7
	501- 1,000	12	12,1	12,1	83,8
	GLHeadcount	1	1,0	1,0	84,8
	More than 100,000	15	15,2	15,2	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - 100	17	17,2	17,2	17,2
	1,001- 5,000	31	31,3	31,3	48,5
	101- 500	21	21,2	21,2	69,7
	5,001- 10,000	15	15,2	15,2	84,8
	501- 1,000	14	14,1	14,1	99,0
	LcHeadcount	1	1,0	1,0	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BAC+3	4	4,0	4,0	4,0
	BAC+4	2	2,0	2,0	6,1
	BAC+5	69	69,7	69,7	75,8
	BAC+6 ou plus	23	23,2	23,2	99,0
	Educ	1	1,0	1,0	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Board member	3	3,0	3,0	3,0
	CEO/President/Managing director	3	3,0	3,0	6,1
	Head of business unit or department	7	7,1	7,1	13,1
	IT staff	2	2,0	2,0	15,2
	Manager	29	29,3	29,3	44,4
	Marketing staff	2	2,0	2,0	46,5
	Product development staff	5	5,1	5,1	51,5
	Production and process department stuff	21	21,2	21,2	72,7
	QSE department stuff	3	3,0	3,0	75,8
	Role	1	1,0	1,0	76,8
	Sales staff	3	3,0	3,0	79,8
	Senior VP/VP/Director	20	20,2	20,2	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1B- 4.99B	15	15,2	15,2	15,2
	1M- 49M	15	15,2	15,2	30,3
	250M- 499M	3	3,0	3,0	33,3
	500M- 999M	11	11,1	11,1	44,4
	50M- 249M	14	14,1	14,1	58,6
	GLRev	1	1,0	1,0	59,6
	Less than 1M	15	15,2	15,2	74,7
	More than 5B	25	25,3	25,3	100,0
	Total	99	100,0	100,0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1B- 4.99B	2	2,0	2,0	2,0
	1M- 49M	21	21,2	21,2	23,2
	250M- 499M	9	9,1	9,1	32,3
	500M- 999M	22	22,2	22,2	54,5
	50M- 249M	13	13,1	13,1	67,7
	LcRev	1	1,0	1,0	68,7
	Less than 1M	15	15,2	15,2	83,8
	More than 5B	16	16,2	16,2	100,0
	Total	99	100,0	100,0	

Fig. 2. Some descriptive statistics analysis related to respondents Demographic Factors

This summarizes the descriptive estimates in percentage, frequency, and cumulative percentage, for the respondents' and firm's demographic features. In sum, 86.9 percent of the respondents were male; more than 52 percent are between 28 up to 35 years old, about 86percent of respondents have at least an educational background of Bac + 5. Regarding the role of respondent criteria, the results show that 29 are managers, 20.2 percent are Senior VP, VP, or director, and 21.2 are Production and process department staff. Regarding the firm's data, the sample includes several activities sectors and with a different type of business.

	Cronbach's Alpha	rho_A	Composite Reliabilit	Average Variance Extracted (AVE)
A	0.932	0.933	0.967	0.936
BCM	0.984	0.985	0.992	0.984
BCP	0.970	0.972	0.985	0.971
BDA	0.965	0.965	0.983	0.966
C	0.978	0.978	0.989	0.979
CCS	0.919	0.925	0.961	0.925
CI	0.952	0.952	0.977	0.955
CM	0.982	0.982	0.991	0.982
Competition capability	0.987	0.987	0.994	0.987
D	0.949	0.949	0.975	0.952
DS	0.969	0.969	0.985	0.970
EC	0.893	0.895	0.949	0.903
EMRP	0.968	0.969	0.984	0.969
F	0.930	0.931	0.966	0.934
GD	0.930	0.930	0.966	0.935
HAS	0.930	0.931	0.966	0.934
HI	0.741	0.798	0.882	0.790
I	0.910	0.910	0.957	0.918
ID	0.799	0.862	0.907	0.829
IOTS	0.979	0.979	0.990	0.980
ISC	0.910	0.910	0.957	0.918
ITS	0.952	0.952	0.977	0.955
KM	0.973	0.974	0.987	0.973
MES	0.992	0.992	0.996	0.992
MT	0.966	0.966	0.983	0.967
P	0.978	0.978	0.989	0.979
PPC	0.889	0.889	0.947	0.900
Q	0.978	0.978	0.989	0.979
RAp	0.976	0.976	0.988	0.977
RP	0.970	0.972	0.985	0.971
SCI	0.979	0.979	0.990	0.980
SCO	0.979	0.979	0.990	0.980
SES	0.972	0.973	0.986	0.973
SI	0.946	0.949	0.974	0.949
SMCT	0.982	0.982	0.991	0.982
SSC	0.910	0.910	0.957	0.918
SSCI	0.988	0.989	0.994	0.988
TE	0.902	0.910	0.953	0.911
VI	0.966	0.966	0.983	0.967
VS	0.995	0.995	0.997	0.995
WSH	0.846	0.920	0.927	0.864

Fig. 3. Outer Loading and Internal Reliability and Validity

5.2 Outer loading and internal reliability and validity

A factor model is performed to elaborate the constructs and their factors using SmartPLS software. the test is performed to understand constructs and relationship between them basing on loading values, path coefficient value and R-square value. Sustainable supply chain innovation (SSCI) is strongly determined by two items (SCI 1–2). Sustainable supply chain sustainability (SCS) is strongly determined by two items (SCI 1–2). The innovative supply chain is also strongly determined by two items (ISC 1–2). The R-square value for SSCI, SSC, ISC is 88.6 percent, 91.3 percent, and 91.3 percent respectively. For supply chain integration (CSI), business continuity management (BCM), supply chain orientation (SCO), competition capability (CC), sustainable environment strategy (SES), they

are determined based on second-order constructs. Fig. 3 indicates the outer loading values of all the constructs' dimensions and their items, along with the internal reliability and validity.
For results interpretation, it is required for the minimum acceptable level for factor loading Cronbach's alpha and CR a value of 0.70, while a value of 0.50 is required for average variance extracted (AVE) is. According to the estimated values reported in Fig. 3 the minimum value of Cronbach's is 0.741 and the minimum value of CR is 0.79, which confirms that all the constructs, their dimensions, and so our proposed model are valid and internally reliable.

5.3 Discriminant validity and SEM estimations

Fig. 4 shows the discriminant validity based on the Fornell-Larcker criterion. The results of this process verification are confirming external validity and reliability for that all the constructs.

	A	BCM	BCP	BDA	C	CCS	CI	CM	Compet	D	DS	EC	EMRP	F	GD	HAS	HI
A	0.968																
BCM	0.959	0.992															
BCP	0.952	0.978	0.986														
BDA	0.901	0.910	0.920	0.983													
C	0.956	0.982	0.975	0.924	0.989												
CCS	0.846	0.855	0.866	0.919	0.869	0.962											
CI	0.943	0.969	0.962	0.911	0.965	0.858	0.977										
CM	0.958	0.983	0.977	0.926	0.980	0.874	0.967	0.991									
Co...	0.961	0.986	0.980	0.929	0.983	0.877	0.970	0.985	0.994								
D	0.941	0.968	0.961	0.908	0.964	0.869	0.951	0.967	0.970	0.976							
DS	0.898	0.908	0.917	0.967	0.921	0.923	0.908	0.923	0.926	0.906	0.985						
EC	0.915	0.943	0.935	0.883	0.939	0.829	0.926	0.942	0.945	0.922	0.880	0.950					
EMRP	0.951	0.977	0.970	0.919	0.974	0.871	0.960	0.975	0.978	0.959	0.918	0.934	0.984				
F	0.932	0.959	0.952	0.900	0.955	0.842	0.942	0.958	0.961	0.940	0.897	0.913	0.950	0.967			
GD	0.932	0.959	0.952	0.900	0.955	0.843	0.942	0.958	0.961	0.940	0.897	0.913	0.950	0.931	0.967		
HAS	0.932	0.958	0.951	0.901	0.955	0.849	0.942	0.957	0.960	0.941	0.905	0.915	0.950	0.932	0.931	0.967	
HI	0.813	0.827	0.832	0.922	0.836	0.819	0.811	0.841	0.828	0.818	0.892	0.790	0.833	0.809	0.811	0.827	0.889
I	0.922	0.949	0.942	0.890	0.945	0.833	0.932	0.948	0.951	0.930	0.887	0.903	0.940	0.921	0.920	0.922	0.800
ID	0.898	0.923	0.918	0.860	0.921	0.858	0.899	0.925	0.928	0.904	0.856	0.866	0.912	0.922	0.891	0.900	0.744
IOTS	0.957	0.982	0.976	0.925	0.979	0.870	0.966	0.980	0.983	0.966	0.935	0.935	0.974	0.957	0.957	0.955	0.840
ISC	0.922	0.949	0.942	0.890	0.945	0.833	0.932	0.948	0.951	0.930	0.887	0.903	0.940	0.921	0.920	0.922	0.800
ITS	0.943	0.969	0.962	0.911	0.965	0.858	0.952	0.967	0.970	0.951	0.916	0.934	0.960	0.942	0.942	0.965	0.836
KM	0.953	0.979	0.972	0.921	0.976	0.865	0.963	0.978	0.981	0.962	0.918	0.936	0.971	0.953	0.953	0.952	0.832
MES	0.963	0.988	0.982	0.931	0.985	0.876	0.972	0.987	0.990	0.972	0.928	0.947	0.981	0.963	0.963	0.962	0.845
MT	0.897	0.906	0.916	0.966	0.919	0.919	0.907	0.921	0.925	0.904	0.967	0.879	0.914	0.896	0.896	0.897	0.898
P	0.956	0.982	0.975	0.924	0.978	0.869	0.965	0.980	0.983	0.964	0.921	0.939	0.974	0.955	0.961	0.955	0.836
PPC	0.912	0.928	0.933	0.913	0.937	0.846	0.924	0.941	0.932	0.919	0.912	0.891	0.932	0.910	0.911	0.914	0.869
Q	0.956	0.982	0.975	0.924	0.978	0.869	0.965	0.980	0.983	0.964	0.921	0.939	0.974	0.955	0.955	0.955	0.836
RAp	0.955	0.980	0.974	0.923	0.977	0.869	0.964	0.979	0.982	0.963	0.920	0.938	0.972	0.954	0.954	0.954	0.836
RP	0.953	0.970	0.972	0.970	0.975	0.919	0.962	0.977	0.980	0.961	0.969	0.936	0.970	0.952	0.952	0.952	0.884
SCI	0.957	0.982	0.976	0.925	0.979	0.874	0.966	0.981	0.983	0.966	0.922	0.941	0.974	0.957	0.957	0.956	0.823
SCO	0.957	0.982	0.976	0.925	0.979	0.874	0.966	0.981	0.983	0.966	0.922	0.941	0.974	0.957	0.957	0.956	0.823
SES	0.953	0.973	0.972	0.922	0.976	0.871	0.963	0.977	0.980	0.962	0.926	0.938	0.971	0.953	0.953	0.952	0.818
SI	0.940	0.967	0.960	0.909	0.963	0.854	0.950	0.965	0.968	0.949	0.906	0.923	0.958	0.940	0.940	0.940	0.812
SMCT	0.905	0.915	0.924	0.974	0.928	0.928	0.923	0.930	0.933	0.913	0.975	0.888	0.923	0.905	0.905	0.905	0.901
SSC	0.922	0.949	0.942	0.890	0.945	0.833	0.932	0.948	0.951	0.930	0.887	0.903	0.940	0.921	0.920	0.922	0.800
SSCI	0.930	0.956	0.949	0.899	0.952	0.846	0.940	0.954	0.957	0.939	0.896	0.913	0.948	0.930	0.922	0.929	0.799
TE	0.858	0.871	0.878	0.933	0.883	0.885	0.886	0.886	0.890	0.864	0.935	0.833	0.911	0.855	0.855	0.859	0.844
VI	0.944	0.976	0.964	0.924	0.967	0.870	0.954	0.969	0.972	0.953	0.920	0.928	0.962	0.944	0.944	0.943	0.856
VS	0.964	0.989	0.983	0.935	0.987	0.884	0.974	0.988	0.991	0.973	0.934	0.948	0.982	0.964	0.964	0.963	0.850
WSH	0.852	0.865	0.872	0.926	0.877	0.876	0.864	0.880	0.884	0.859	0.928	0.871	0.873	0.849	0.889	0.852	0.851

Fig. 4. A part of discriminant validity (Fornell-Larcker Criterion)

In Fig. 6 and 7 are presenting total effects and specific indirect effects calculation for our model. The results of total effects calculation are confirming a significant effect of Business continuity management, competition capability, supply chain integration, supply chain orientation, and sustainable environment strategy in maximizing sustainable

supply chain innovation in the manufacturing firms with the mediation of industry 4.0 technological systems. The human and social approach has no significant impact on the maximized function (SSCI). The validated mode is presented in Fig. 5. The specific indirect calculation results are confirming the same conclusions of the total effect calculation.

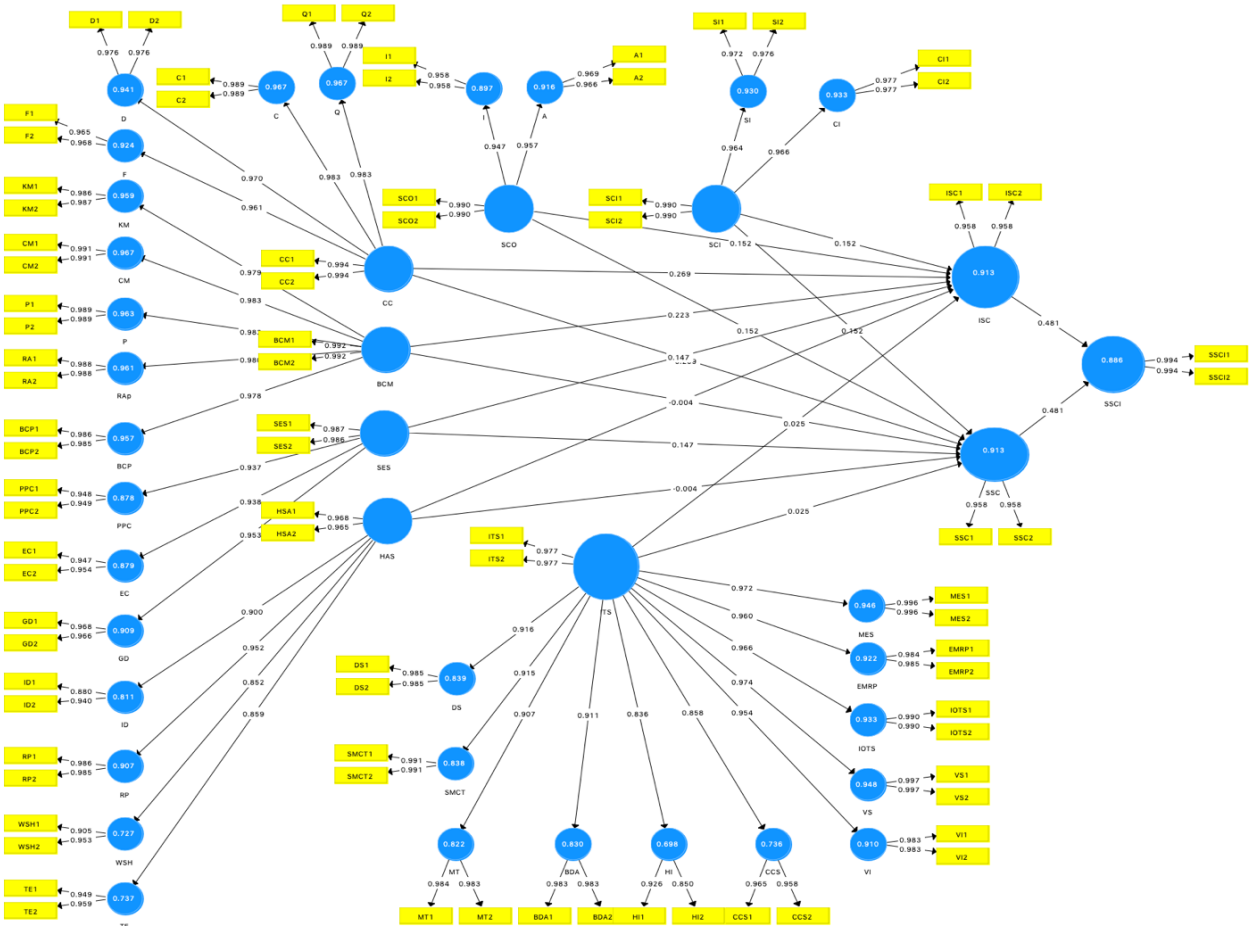

Fig. 5. Validated business model

	SSCI
Competition capability	0.259
BCM	0.215
SCI	0.146
SCO	0.146
SES	0.142
ITS	0.024

Fig. 6. Total effect

	Specific Indirect Effects
SES -> ISC -> SSCI	0.071
SCO -> ISC -> SSCI	0.073
BCM -> SSC -> SSCI	0.107
SES -> SSC -> SSCI	0.071
ITS -> ISC -> SSCI	0.012
Competition capability -> ISC -> SSCI	0.129
Competition capability -> SSC -> SSCI	0.129
HAS -> SSC -> SSCI	-0.002
ITS -> SSC -> SSCI	0.012
SCI -> ISC -> SSCI	0.073
HAS -> ISC -> SSCI	-0.002
SCI -> SSC -> SSCI	0.073
SCO -> SSC -> SSCI	0.073
BCM -> ISC -> SSCI	0.107

Fig. 7 Specific indirect effect

6. Conclusion

This study aimed to investigate the supply chain innovation and sustainability in the Moroccan industrial field, by considering the mediation role that Industry 4.0 technological systems have on the main constructs. The study has used the primary data exploratory technique for data collection, along with the help of online questionnaires emailed to professionals and experts in Moroccan industrial firms. Using SPSS and SmartPLS software, several tests were performed on the 99 completed responses. Basing on factor loading values, Cronbach's alpha, composite reliability, AVE, and discriminant validity, internal and external validity and reliability were confirmed for the constructs. The "total effect" analysis is confirming the importance of the following in achieving Sustainable supply chain Innovation: Supply chain integration, competition capability, business continuity management, social environment strategy, and Industry 4.0 technological systems. The human and social approach has no significant impact on SSCI. The "specific indirect effect" analysis confirms the indirect link between all other constructs except the Human social approach. The management and policymakers of the Moroccan industrial field are advised to consider strongly this model and the important mediation role of Industry 4.0 technological systems in achieving sustainable and supply innovation. More studies must be performed regarding strategic and operational plans to guarantee the adequate application of the business model, all parties' engagement is required in this concern to enhance innovation and sustainability in the supply chain of Moroccan manufacturing firms and so for the industrial field.

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