

Study Of Role Of Digitization In Sustainable Business In Auto Industry In India Using Thematic Content Analysis, Spearman Analysis And Review Of Literature.

¹Prakash D.Wagh., ²Dr.Ajim Shaikh.

¹Research scholar. MITADT University Pune.

² Guide. MITADT University Pune.

Article History: Received:11 January 2021; Accepted: 27 February 2021; Published online: 5 April 2021

Abstract: Progress in digital technologies and Cyber physical technologies in last one decade has created immense opportunities for business firms and companies to adopt sustainable practices in their end to end business cycle. This is helping business to conserve the various resources like energy, material ,manual efforts, water and contributing to lower cost of goods sold ,ultimately making the balance sheet and profit and loss account green and healthy. The consumer and NGO pressures , Government rules and regulations and depleting resources is also acting as a trigger for businesses to adopt sustainability. Digitization is helping companies in achieving the sustainability aspect in their operations ,supply chain and other parts of the business. This paper is based on the interaction and interviews with 40 business leaders from Automobile industry in India during the last 2 years and literature study of digitization and sustainability goals and other related research articles. The interview output was analyzed using thematic sematic analysis (TMC) and collaborated with finding from review of literate. The study concluded that there is enough positive and significant relationship between Digitization and sustainability (Sustainable business) in Auto industry in India.

Keywords : Digitization ,Sustainability , Green , Environment, Automobile , Patterns ,Themes ; Industry 4.0 , Conservation of resources

Preface : in 1990’s we saw emergence of Business process reengineering (BPR) , Just in time (JIT) ,Kanban ,Total productive maintenance and kaizen as some of the leading business or enterprise wise business initiatives. Current climate change ,ozone layer depletion, generation of waste and pollution is calling for sustainability initiative to save the overall ecosystem for the betterment of mankind. Sustainability is also a philosophy like Total productive maintenance ,Total quality management and its adoption enterprise wise is as easy as of those initiatives. The internet revolution ,Automation and energy efficient machine ,Industry 4.0 ,Blockchain , Machine learning ,Augmented reality ,virtual reality ,cloudification and many other digital technologies are helping businesses to adopt Sustainability in their operations.Sustaibaility with digitization is a creating agile ;productive and safe workplace as well as eco friendly product and services for empowered customers.

Objective : To understand and review of sustainability adoption by Automobile industry in their operations using digital technology .The study was limited to Automobile manufacturers (4-wheeler cars in India).

Methodology : The Methodology used was unstructured interview with 40 leaders supported by relevant review of literature. The analysis of data was done using a mixed methodology consisting of :

- Thematic Analysis to arrive at the critical variables and thematic relationship.
- Spearman statistical analysis to statistically prove the relationship among the variables.

We consider this Hybrid methodology to be unique in analyzing the unstructured interview data , thematic analysis shows the prominent variables with relationship probability while Spearman Co-efficient establishes statistically the relationship. This leaves no doubt on outcomes or conclusion as thematic analysis is supported by statistical analysis .

The subject size for unstructured interview was 40 and consisted of :

Table 1 : Segment and interviews

Segment	Designations of the candidate	No. of Leaders interviewed
Entry level passenger cars	Chief marketing Manager ,Sales manager ,Production Manager; IT head	10(Random chance occurrence during business visit)
Sedan Passenger Cars	SCM Manager ,Production Manager ,EHS Head ,Sales engineer; IT Manager	12 (Random chance occurrence during client visits)
Mini SUV	Production executive ,Logistics manager , IT head , DGM -SCM	8 (Random chance occurrence during client visits)

Study Of Role Of Digitization In Sustainable Business In Auto Industry In India Using Thematic Content Analysis, Spearman Analysis And Review Of Literature.

SUV	Sales executive ,dealers ,service station executive , Factory head	8 (Discussion during proposal defense)
Luxury cards	Dealer ,service head , sales executive ,IT manager	2 (chance occurrence during accompanying the client visit)

Randomness in this unstructured discussion and interviewed helped to remove the bias and typical safeguarded answers from client executives. Moreover, most of these visits in last 2 year to client place /office/Factories were for Presales ,client relationship and proposals not related to sustainability. The visits were more related to ERP implementation, but this opportunity was used to gauge the sustainability initiatives going on in the organization from strategy to execution.

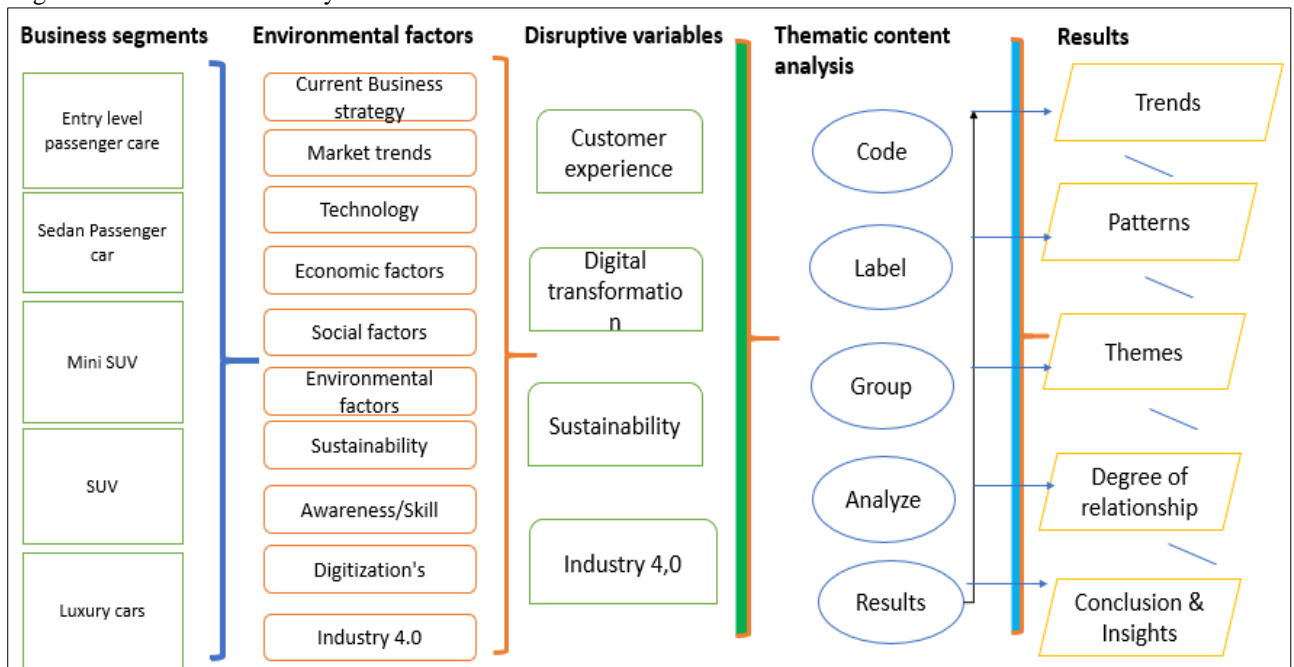
The input from these unstructured reviews were followed by review of literature on digitalization and sustainability. The qualitative study was done with the sole aim of checking the importance businesses are giving to sustainability angles and the various initiative goings in sustainability areas using digitization.

Thematic content analysis (TCA) Methodology

TCA as it is known in qualitative data analysis is a well-known technique for converting the open interview /unstructured interview from the participants into logical and structural analysis. While the process of labelling ,coding and themes can be achieved using simple tools like excel , there are special software’s like Altos and freeware to analyses and interpreted the Thematic control analysis.

Irrespective of the tools used , the TCA provides common themes by identifying the patterns from the data collected. The researcher analyses and principates the details from selected list of common themes to give credentials to the participants of view across various interviewed. The coding by the researchers make very reasonable attempt to directly capture the view of the respondent .While coding and labelling by the researchers have some flexibility in terms of “Interpretation” . it is bare minimum so as to not to deviate from the input received.

Fig 1 : Thematic content analysis construct



Spearman Rank Coefficient of correlation.

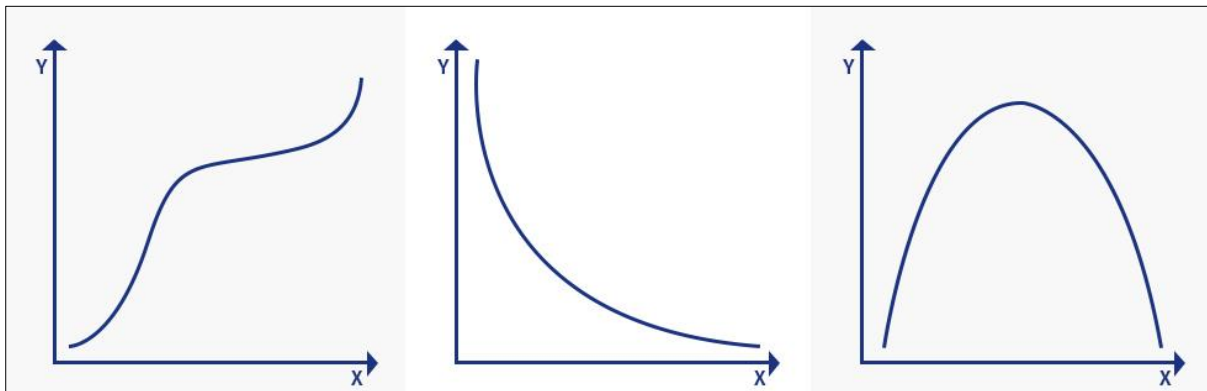
The Spearman’s rank coefficient of correlation is a nonparametric measure of rank correlation (statistical dependence of ranking between two variables).

For the calculation and significance testing of the ranking variable, it requires the following data assumption to hold true:

- Interval or ratio level
- Linearly related
- Bivariate distributed

If your data doesn't meet the above assumptions, then you would need Spearman's Coefficient. It is necessary to know what monotonic function is to understand Spearman correlation coefficient. A monotonic function is one that either never decreases or never increases as it is an independent variable increase. A monotonic function can be explained using the image below:

Figure 2: Monotonic Function



The image explains three concepts in monotonic function:

1. Monotonically increasing: When the 'x' variable increases and the 'y' variable never decreases.
2. Monotonically decreasing: When the 'x' variable increases but the 'y' variable never increases
3. Not monotonic: When the 'x' variable increases and the 'y' variable sometimes increases and sometimes decreases.

Monotonic relation is less restrictive when compared to a linear relationship that is used in Pearson's coefficient. Although monotonicity is not the ultimate requirement for Spearman correlation coefficient, it will not be meaningful to pursue Spearman's correlation without actually determining the strength and direction of a monotonic relationship if it was already known that the relationship between the variable is non-monotonic.

Spearman correlation coefficient: Formula

$$r_R = 1 - \frac{6\sum_i d_i^2}{n(n^2 - 1)}$$

n = number of data points of the two variables

d_i = difference in ranks of the "ith" element

The Spearman Coefficient, ρ , can take a value between +1 to -1 where,

- A ρ value of +1 means a perfect association of rank

- A ρ value of 0 means no association of ranks
- A ρ value of -1 means a perfect negative association between rank

Literature review :

Vinit Parida ,David Sjödin & Wiebke Reim (2019) in their study tried to come out with a framework for communicating and setting the direction for digitization ,Business models and sustainability. The article points out that the amount of productivity gains and savings using digital technology is significant and at the same time it is contributing to Sustainability by conserving the resources using the digital technology stride.

Carmen Isensee et tal (2020) in their rearsch could found ten links among business culture ,Sustainability and digitization. They have contributed a new concept of Green digitalization tools emphasizing the importance of digitization in sustainability adoption in Mid and SME companies.

Federica Ricci et tal (2020) in their study of Italian companies found that those companies which have good reputation for corporate sustainability is likely to get good valuation at marketplace if they showcase their digitization and sustainability initiave.

R. R. Sharma& S. Mukherji (2015) in their article points out consumer ,investors ;government and other stakeholders are influencing the adoption of green corporate compliance as well as accountability from the management. Changes in climate patterns ,rising energy consumption and prices are forcing government to enact laws in protecting the environment and as such change management and involvement of people as well as top management vision and leadership has become important for making sustainability in business a success. The article mentions innovations done in the oil drilling processes both physical as well as software related during this journey of aim of becoming carbon neutral.

Marlen Gabriele Arnold \$ Anne Fischer (2019) in their research article do agree that in current years the duo of digitization and sustainability has emerged as one of the key initiave. However, they also caution that there are both opportunities and threats connected with this approach. They found comprehensive analysis of strength ,opportunities ,weakness and threats is not clearly available. Only positive side of digitization and sustainability is studies but there is scope to complete the entire four quadrants in a quest to understand the overall picture. There attempt to show two examples of digitization and sustainability going hand and hands shows both a progressive pattern as well as some form of tensions in certain areas.

Yasanur Kayikci,(2018) in his research article has emphasized that digitization in the supply chain not only brings benefits of productivity ,agility ,transparency and speed but also the sustainability impact of digitization on supply chain or logistics. He has highlighted that the digitization has helped in reduction of CO2 emission, air and noise pollution, less fuel consumption , less land for transportation as well as social factors of sustainability got benefited through lesser impact of health hazards ,safety on the road ,fuel efficient vehicles ;Labour pattern changes and types of work.

Nada R. Sanders et tal (2019) in their rearsch article stress that entire logistics chain or supply chain have a very high impact on sustainability as it can make the company's entire logistics chain green or sustainable. They also mention that digitization has come handy to achieve this "Green" part of logistics chain for companies. They cite examples of various digital technologies including digital applications , Process automation ,AI ,Blockchain and big data as some of the digital technologies which are helping to make the business supply chain a sustainable and greener one.

Morteza Ghobakhloo (2020) in his research paper tried to construct structural model which could interpret the contextual relationship between industry 4.0 sustainability aspects. The study found a very significant relationship exists among various sustainability elements of industry 4.0 adoption. He has pointed out that industry 4.0 is defiantly contributing to sustainability by outcomes such as energy efficiency , emission reduction and social welfare and social improvements.

Middleton, K. (2005) shares his experience which is not an industry one but related to the institutions like libraries , reference archives ,Heritage material which was carried out in USA during 2005. The vast amount of physical papers was converted into digital one using scanning ,digital metadata , various digital formats and software applications. This has helped to create a digital ,paperless knowledge base which was easy to use ,search was better , organization was easy. The study points out that this was a ,type of sustainability initiative as it has reduced the efforts ,resources, easy access to learners ,student and professors ,long term durability ,creating a sustainable digital repository. It may seem an odd example in this paper , but I thought of including this to demonstrate the outreach of digital and sustainability connection.

Müller, J.M.; Kiel, D.& Voigt, K.(2018) in their study pointed out that climate/environment and social benevolence are contributing positively to the drive for adopting the new initiative of industry 4.0. However, the study also pointed out that this context changes with the industry and the viability and future also changes due to various hurdles in strategizing and implementing these initiatives. The article clearly points to the advantages which industry 4.0 can bring in the sustainability area for the business which crosses economical benefits and enters ecology, social and environmental domains.

Adi Kuntsman & Imogen Rattle (2019) in their article has opposed the very basic fundamental that digitization and sustainability go hand in hand and given a new perspective. This is exactly opposite to the widely accepted idea of digitalization helping sustainable operations. They call for a more pragmatic and innovative shift in sustainability study in the context of digitization. The digitization according to their study also results in substantial environmental damage to produce the digital devices, e-waste generation and use of increasing electricity. This inbuilt carbon footprint of digital needs to be considered while assessing the role of digitization in sustainability. According to me this is a fair assumption and the total carbon footprint also needs to include these components while arriving at net carbon footprint under an initiative.

Ang Liu, Qinghai Zhu and Stefan Seuring (2020) in a special issue on new technology and implication of the same on sustainability in business, factory and supply chain found that the new technologies are playing an important role in business as well as having a good impact on sustainability. They also found that the new digital technology research is often limited to one or two technologies and their effect on sustainability of the business. They have suggested a comprehensive approach wherein all the related new digital technologies are evaluated with respect to their impacts and correlation with sustainability in manufacturing and logistics. They also pinpointed that the approach should consider all the three tenants of sustainability: environmental, social and financials and a need to balance all these three. Here they are also hinting at weighing Pros and cons as well as ROI (Rate of return). The editors of this article also found that many researchers use different conceptual models to come out with valuable findings. The suggestion is to have a framework which can accommodate multiple technologies related to manufacturing, logistics, SCM and sales and apply it for a more comprehensive study where generalizations can become much simpler. The authors call for new models of research including simulations and game theory for realistic and pragmatic studies in these areas/

Stefan Seidel, Jan Recker and Jan vom Brocke (2013) in their article shared their experience of a software solution which has helped a customer to implement business processes and practices which were sustainable in nature. The solution provided took care of conservation aspects of sustainability in the day-to-day operations in designing and implementing the system. Based on this the authors developed a structured framework while using information or digital systems which can help companies to adopt sustainable practices in most of their operations. The suggested framework included awareness and understanding of the current and incoming environmental requirements, developing ecofriendly and employee friendly standard practices or operating processes, conceptualize, design and implement any digital information systems on the basis of the above two requirements and the last point was regarding successful execution of these software's to adopt sustainability.

Parida V, Sjödin D & Reim W.(2019) in their article acknowledge that any digital initiative execution is a challenging one and requires commitment which is ongoing and extends to continuous improvement even after implementation. The authors point out that sustainable industry is one of the objectives or goals in this long journey wherein success depends on careful planning and aiming on economic, social and sustainable benefits over a period. The digitization helps in automation; elimination of error-prone tasks, increases efficiency, reduces waste and conserves resources leading to gains in quality and optimum usage of resources, thus increasing the sustainability of operations. The authors suggest that sustainability should be addressed from product design to end of product lifecycle taking care of the health and safety of all the stakeholders.

Opazo-Basáez M, Vendrell-Herrero F, Justina .(2018). Their article emphasizes that the automobile is one of the primary industries which casts a critical impact on the environment and as such digitization and sustainability agenda has been on the radar of automotive companies for a long time. The authors point out that along with servitization, automotive companies are widely adopting green practices using digital platforms and digital software's to monitor and control the sustainable projects or programs which help in reduction in waste, emission, energy conservation, water management and health and safety at workplace.

Review of selected literature on Digitization and sustainability clearly establishes a significant correlation between these two. Considering the importance of conservation of resources, stringent government regulation, consumer pressure, brand image and to have a competitive edge, more and more companies are adopting a twin strategy of digitization and sustainability.

Analysis of Open interviews Data

The 40 unstructured open interviews of Automotive business leaders consisted of following questions and labels to codify the response.

Table 2: List of Some of the main unstructured questions

S N	Area	Unstructured Questions
1	Current Business Strategy	Which are the main elements of your current Business strategy
2	Market trends	Which are the 2-3 technology trends you are working on
3	Technology	which are the top 3-4 areas in which your company is heavily investing
4	Economic Factors	How new digitalization and innovations helping you to keep the affordability
5	Social factors	Do your company have CSR policy and initiative including yearly reporting
6	Environmental factor	How your company is dealing with low emission norms and other environmental regulations?
7	Sustainability	Are there any sustainability initiative going on currently with the availability of high digitization?
8	Awareness	Are you aware of the UN sustainability goals ? Can you elaborate 1 or 2 of these sustainability goals?
9	Digitization	Digitization and sustainability generally result in conservation of resources in which areas?
10	Industry 4.0	How your company is doing with respect to industry 4.0 and IOT

The Responses during the random open interviews were labelled under following categories :

Table 3 : Labelling schema during interviews

A	B	C	D	E	F	G	H	I	K	L	M	N
Custo mer centri city	New produc t innova tion	Digit al busin ess	Sustaina bility	Indu stry 4.0	Conne cted Vehicl e	Saf ety	SC M	Qual ity	Hig h qual ity serv ice	Purcha sing	high level understa nding	Not aw are

The Responses from 40 random auto leaders were analyzed using labelling

Table 4: Labelling of the interview responses.

Respon dent	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
2	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
3	A,E,F	C,D,H	C,D,H, L	H;L,C	D	C,D,H,L	C,D,E	M	B,H,L	M
4	A,C,D, E	C,D,E, L	H,C,I	H,I,C,D	D	C,D,H,L	C,D,E,F, H	M	H,I,L	M
5	A,B,C, D	C,D,L, F	C,D,F	H;L,I,C	D	H,I,C,L, E	C,D,H,I;L	D	H,I,L	M

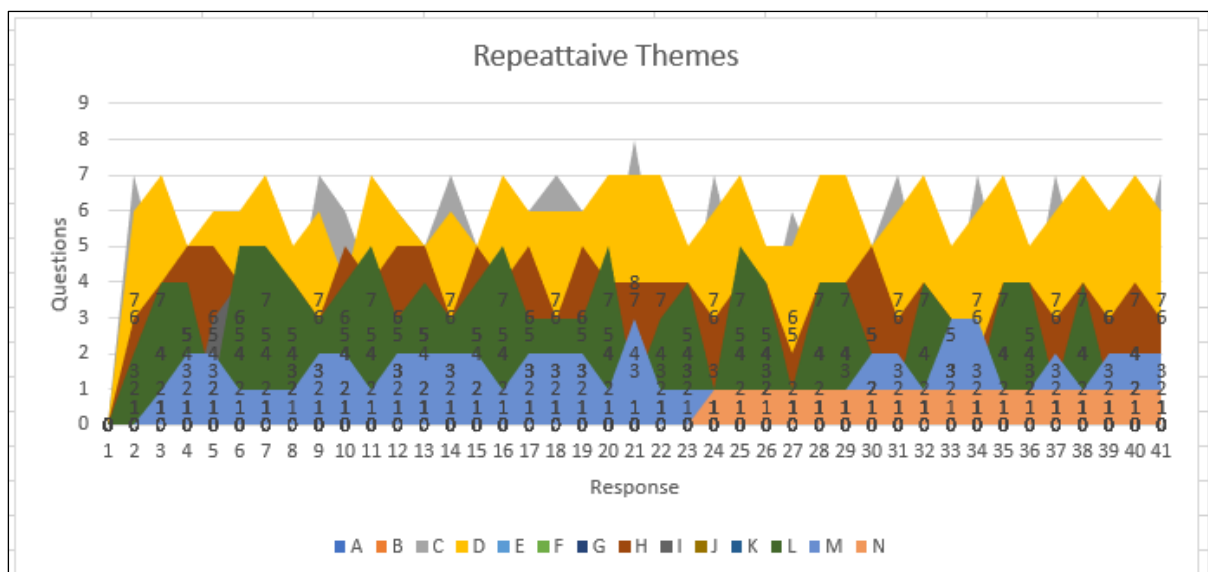
6	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
7	C,D,E	C,D,E, F	H,L,K, E	H,I,L	D	C,D,E,F	H,I,L	D	H,I,L,K	M
8	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
9	A,E,F	C,D,H	C,D,H, L	H;L,C	D	C,D,H,L	C,D,E	M	B,H,L	M
10	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
11	A,C,D, E	C,D,E, L	H,C,l	h;l,c,d	D	C,D,H,L	C,D,E,F, H	M	H,I,L	M
12	A,E,F	C,D,H	C,D,H, L	H;L,C	D	C,D,H,L	C,D,E	M	B,H,L	M
13	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
14	A,E,F	C,D,H	C,D,H, L	H;L,C	D	C,D,H,L	C,D,E	M	B,H,L	M
15	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
16	A,C,D, E	C,D,E, L	H,C,l	h;l,c,d	D	C,D,H,L	C,D,E,F, H	M	H,I,L	M
17	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
18	A,C,D, E	C,D,E, L	H,C,l	h;l,c,d	D	C,D,H,L	C,D,E,F, H	M	H,I,L	M
19	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
20	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
21	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
22	C,D,E	C,D,E, F	H,L,K, E	H,I,L	D	C,D,E,F	H,I,L	D	H,I,L,K	M
23	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
24	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
25	C,D,E	C,D,E, F	H,L,K, E	H,I,L	D	C,D,E,F	H,I,L	D	H,I,L,K	M
26	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
27	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
28	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
29	A,E,F	C,D,H	C,D,H, L	H;L,C	D	C,D,H,L	C,D,E	M	B,H,L	M
30	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
31	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
32	C,D,E	C,D,E, F	H,L,K, E	H,I,L	D	C,D,E,F	H,I,L	D	H,I,L,K	M
33	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
34	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M

Study Of Role Of Digitization In Sustainable Business In Auto Industry In India Using Thematic Content Analysis, Spearman Analysis And Review Of Literature.

35	C,D,E	C,D,E, F	H,L,K, E	H,I,L	D	C,D,E,F	H,I,L	D	H,I,L,K	M
36	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
37	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
38	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M
39	C,D,F	H;L,D	C,L,E	C,D,H, L	D	C,D,E	H,L,D	D	H,K,L	M
40	B,C	C,D	C;H,L	C,D	D	C,D,I	C,D,H,L	M	C,D,H, L	M

Patterns & Themes out of the analysis.

Fig 2 : Theme/Pattern analysis of interview responses



The Patterns clearly indicates following four important themes coming out of the analysis and Sustainability and digitalization are the top 2. The review of literature also suggests a significant and positive correlation ship between sustainability and digitization.

Table 5 : Top 4 Themes/Pattern in su business in Indian Auto Industry.

SN	Top Theme /pattern	
1	D	Sustainability
2	C	Digitization
3	H	SCM
4	L	Purchasing

Combining review of literature findings as well as qualitative analysis based on 40 Automobile leaders unstructured review & analysis clearly indicates a positive and significant relationship between sustainability and digitalization. However, this needs statistical backing. We have decided to back this using Spearman Nonparametric Co-relation coefficient. Though the thematic analysis shows the corresponding changes (Up/down) with the help of graphical and numerical representation , it is not considered enough from rearsrch point to define the direction and degree of relationship between the variables under study.

Based on extensive discussions and review of literature , we have decided to go for Spearman Nonparametric correlation estimation for establishing a statistically significant relationship between

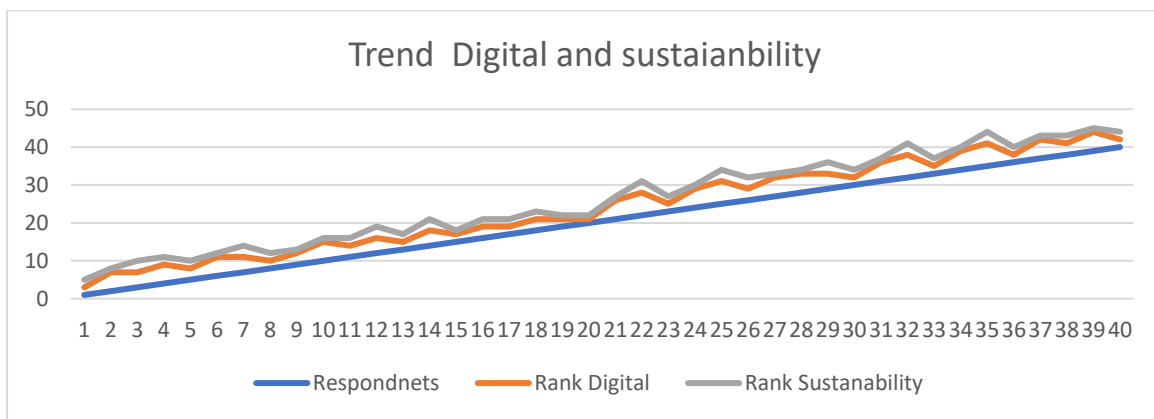
1. Digitization and sustainability
2. Industry 4.0 and sustainability

Spearman Nonparametric Co-relation Coefficient

Spearman's correlation measures the strength and direction of monotonic association between two variables. Monotonicity is "less restrictive" than that of a linear relationship.

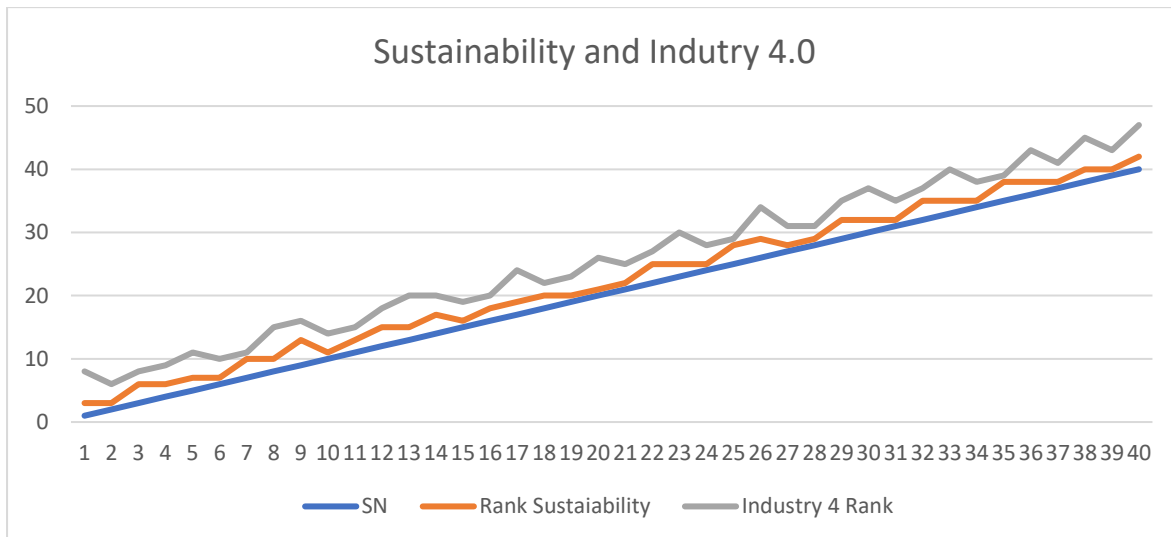
A monotonic relationship is not strictly an assumption of Spearman's correlation. That is, you can run a Spearman's correlation on a non-monotonic relationship to determine if there is a **monotonic component** to the association. However, you would normally pick a measure of association, such as Spearman's correlation, that fits the pattern of the observed data. That is, if a scatterplot shows that the relationship between your two variables looks monotonic you would run a Spearman's correlation because this will then measure the strength and direction of this monotonic relationship. On the other hand if, for example, the relationship appears linear (assessed via scatterplot) you would run a Pearson's correlation because this will measure the strength and direction of any linear relationship.

We have analyzed the interview data for Digitization initiative ,Sustainability and Industry 4.0. The paired data comparison for 40 interviews for these variables is done. First step in this was to plat the trend diagrams. The trends diagrams for the paired variables are given below:



Based on the trend pattern , it was decided to use Spearman’s Co-efficient rather than Pearson co-efficient for analysis as the trend diagrams shows a Monotonic and uniform patterns.

Fig 4 : Sustainability and Indutry 4.0 trend



Spearman Co-relation Coefficient analysis.

Study Of Role Of Digitization In Sustainable Business In Auto Industry In India Using Thematic Content Analysis, Spearman Analysis And Review Of Literature.

1. Digitization and sustainability

Respondent	Digital Business	Sustainability	Rank Digital	Rank Sustainability	D=Rank1 - Rank2	D Square
Q.No---->	C	D				
1	7	6	2	2	0	0
2	4	7	5	1	4	16
3	5	5	4	3	1	1
4	4	6	5	2	3	9
5	6	6	3	2	1	1
6	4	7	5	1	4	16
7	3	5	4	3	1	1
8	7	6	2	2	0	0
9	6	4	3	1	2	4
10	4	7	5	1	4	16
11	6	6	3	2	1	1
12	5	5	4	3	1	1
13	7	6	2	2	0	0
14	5	5	4	3	1	1
15	4	7	2	1	1	1
16	6	6	3	2	1	1
17	7	6	2	2	0	0
18	6	6	3	2	1	1
19	4	7	2	1	1	1
20	8	7	1	1	0	0
21	4	7	5	1	4	16
22	3	5	6	3	3	9
23	7	6	2	2	0	0
24	4	7	5	1	4	16
25	3	5	6	3	3	9
26	6	5	3	3	0	0
27	4	7	5	1	4	16
28	4	7	5	1	4	16
29	5	5	4	3	1	1
30	7	6	2	2	0	0
31	4	7	5	1	4	16
32	3	5	6	3	3	9
33	7	6	2	2	0	0
34	4	7	5	1	4	16
35	3	5	6	3	3	9
36	7	6	2	2	0	0
37	4	7	5	1	4	16
38	6	6	3	2	1	1

39	4	7	5	1	4	16
40	7	6	2	2	0	0

Total	237
-------	-----

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

D2 1422
N(M2-1)
63960

P (40) = 0.9777673

2. Sustainability & Industry 4.0

Respondent	Sustainability	Industry 4	Rank Sustainability	Industry 4 Rank	D	D square
1	6	0	2	5	-3	9
2	7	2	1	3	-2	4
3	5	3	3	2	1	1
4	6	2	2	3	-1	1
5	6	1	2	4	-2	4
6	7	2	1	3	-2	4
7	5	4	3	1	2	4
8	6	0	2	5	-3	9
9	4	2	4	3	1	1
10	7	2	1	3	-2	4
11	6	3	2	2	0	0
12	5	2	3	3	0	0
13	6	0	2	5	-3	9
14	5	2	3	3	0	0
15	7	2	1	3	-2	4
16	6	3	2	2	0	0
17	6	0	2	5	-3	9
18	6	3	2	2	0	0
19	7	2	1	3	-2	4
20	7	0	1	5	-4	16
21	7	2	1	3	-2	4
22	5	3	3	2	1	1
23	6	0	2	5	-3	9
24	7	2	1	3	-2	4
25	5	4	3	1	2	4
26	5	0	3	5	-2	4
27	7	2	1	3	-2	4

Study Of Role Of Digitization In Sustainable Business In Auto Industry In India Using Thematic Content Analysis, Spearman Analysis And Review Of Literature.

28	7	3	1	2	-1	1
29	5	2	3	3	0	0
30	6	0	2	5	-3	9
31	7	2	1	3	-2	4
32	5	3	3	2	1	1
33	6	0	2	5	-3	9
34	7	2	1	3	-2	4
35	5	4	3	1	2	4
36	6	0	2	5	-3	9
37	7	2	1	3	-2	4
38	6	0	2	5	-3	9
39	7	2	1	3	-2	4
40	6	0	2	5	-3	9

180

D2	180
N	40
N(M2-1)	63960
p	0.983114447

The analysis here shows that the Spearman coefficient of relationship between :

- Digitalization and sustainability: 0.97 (Very high significant co-relationship)
- Sustainability & Industry 4.0: 0.98 (Very high significant co-relationship)

Barring the scoring bias, in an open unstructured interview as given below ..

- Confirmation bias. Occurs when the person performing the data analysis wants to prove a predetermined assumption.
- Selection bias. This occurs when data is selected subjectively.
- Outliers. An outlier is an extreme data value.
- Overfitting an underfitting response
- Confounding variables.

Even if we consider the bias to the tune of 20 to 30%, due to personal ,professional and company influence , the adjusted Coefficient of correlation will be in the range of :

- Digitalization and sustainability: 0.97 (Very high significant co-relationship)

20% 77 68
30 %

- Sustainability & Industry 4.0: 0.98 (Very high significant co-relationship)

20% 78
30 % 69

Even removing the traditional bias as per review of literature, there is significant positive statistical positive correlation between,

- Digitalization and sustainability
- Sustainability & Industry 4.0:

Findings and observations from interviews with Business leaders

The interviews and discussions with 40 business leaders' overs a span of 2 years bought about significant insights with respect to digitization and sustainability initiatives in Automobile industry in India.

- There is significant positive relationship between digitization and sustainability (68 to 77%) after removing the biases in interview responses.
- There is significant positive relationship between Industry 4.0 and sustainability (78 to 69 %) after removing the biases in interview responses.
- Almost all those interviewed agreed that sustainability has become one of the strategic points along with business growth in last 10 years.
- Almost 100 % of the companies have CSR (Corporate social responsibility) initiatives in one or the other form and they are getting reported in company's annual report.
- Almost 90 % of the interviewed informed that digitization coupled with sustainability goals are going on in their organization and they are in various stages of implementation.
- Shop floor automation ,Supply chain & Green purchasing , these 3 areas are found to be under implementation in at least 60% of the respondent. Balance respondent did not elaborate much on these but nodded it is on their agenda.
- Many leaders still found connecting digitization and sustainability clearly as the software and physical actions part of sustainability often confuse them.
- Most of the leaders are aware of different standards for sustainability , however they could not elaborate much on the details.
- Some of the leaders suggested , that this is focus area but requires expert guidance and lot of investment. (which is not true if we weigh the Pros and cons).
- Business leaders were found to be more aware of benefits due to sustainability than the IT leaders interviewed.
- 80% of the leaders say that industry 4.0 and IOT are still far away as currently only proof of concept or some sample projects are going on.

Limitation of the study :

- The answers during the interview sometimes were found to be influenced by their position ,company's image and sharing of confidential information.
- Sample size of the interview was 40 but it was a random sample and considering that there are only 10 major OEM manufacturers in India , we thought it to be representative.
- No detail elaboration on sustainability initiative was shared. It was brief answers on a high level.(Probability not to divulge details due to confidentiality)

Future Scope :

- A full-blown study on digitization and sustainability in various industries including Automobile can help further to understand the correlation ,impact and Return on investment in detail. Full blown study here means multiple technology and entire product value chain study and not an isolated part to get a clear picture.
- Sustainability benchmarking for the current state of the business is still an issue and there are no industry specific frameworks available to calculate the current state and plan for the further steps in digitization and sustainability.
- Though there are certain measures like CO2 emission ,Carbon footprint ,waste generated amount available , a detailed scorecard covering design to end of lifecycle needs to be put in place. Complete Key performance indicators for sustainability is the need of the hour.
- Digitization itself is creating some environmental issues like e-waste ,consumption of more electricity , these also needs to be factored in research on digitization and sustainability.

References

1. Adi Kuntsman & Imogen Rattle.(2019):Towards a Paradigmatic Shift in Sustainability Studies: A Systematic Review of Peer Reviewed Literature and Future Agenda Setting to Consider Environmental (Un)sustainability of Digital Communication. Environmental communication. Volume 13 ,issue 5. <https://doi.org/10.1080/17524032.2019.1596144>.
2. Ang Liu, Qinghua Zhu & Stefan Seuring.(2020).New technologies in operations and supply chains: Implications for sustainability. International Journal of Production Economics. Volume 229,<https://doi.org/10.1016/j.ijpe.2020.107889>.

3. Carmen Isensee, Frank Teuteberg, Kai-Michael Gries e& Corrado Top.(2020).: The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review. *Journal of cleaner Production*. Volume 275. <https://doi.org/10.1016/j.jclepro.2020.122944>.
4. Denis Roegel.: Sustainable digitization. [Research Report] LORIA - Université de Lorraine. 2012. fhal-02340532f
5. Federica Ricci, Vincenzo Scafarto, Salvatore Ferr & Alberto Tron.(2020),Value relevance of digitalization: The moderating role of corporate sustainability. An empirical study of Italian listed companies. *Journal of Cleaner Production*. Volume 276. <https://doi.org/10.1016/j.jclepro.2020.123282>.
6. Marlen Gabriele Arnold & Anne Fischer .(2019) .Digitization and Sustainability: Threats, Opportunities, and Trade-Offs. *Responsible, Sustainable, and Globally Aware Management in the Fourth Industrial Revolution* .Pages 28. DOI: 10.4018/978-1-5225-7638-9.ch001.
7. <https://www.igi-global.com/chapter/digitization-and-sustainability/227813>
8. Middleton, K. (2005), "Collaborative digitization programs: a multifaceted approach to sustainability", *Library Hi Tech*, Vol. 23 No. 2, pp. 145-150. Emerald group publishing ltd.
9. Morteza Ghobakhloo.(2020). Industry 4.0, digitization, and opportunities for sustainability,
10. *Journal of Cleaner Production*, Volume 252. <https://doi.org/10.1016/j.jclepro.2019.119869>.
11. Müller, J.M.; Kiel, D.; Voigt, K.-I. What Drives the Implementation of Industry 4.0? The Role of Opportunities and Challenges in the Context of Sustainability. *Sustainability* **2018**, *10*, 247. <https://doi.org/10.3390/su10010247>
12. Opazo-Basáez M, Vendrell-Herrero F, Bustinza OF. Uncovering Productivity Gains of Digital and Green Servitization: Implications from the Automotive Industry. *Sustainability*. 2018; 10(5):1524.
13. Parida V, Sjödin D, Reim W. Reviewing Literature on Digitalization, Business Model Innovation, and Sustainable Industry: Past Achievements and Future Promises. *Sustainability*. 2019; 11(2):391.
14. R. R. Sharma , S. Mukherj i: Management of Permanent change. ISBN 978-3-658-05013-9 ISBN 978-3-658-05014-6 (eBook) DOI 10.1007/978-3-658-05014-6 Library of Congress Control Number: 2014956666 Springer New York Heidelberg Dordrecht London
15. Sanders ,Boone ,Ganesan & Wood (2019).Sustainable Supply Chains in the Age of AI and Digitization: Research Challenges and Opportunities. *Journal of business logistics*. Vol.40,Issue 3.<https://onlinelibrary.wiley.com/doi/abs/10.1111/jbl.12224>
16. Stefan Seidel, Jan Recker and Jan vom Brocke. : Sensemaking and Sustainable Practicing: Functional Affordances of Information Systems in Green Transformations. *MIS Quarterly*, pp. 1275-1299 (25 pages).
17. Yasanur Kayikci .(2018).Sustainability impact of digitization in logistics. *Procedia Manufacturing*. Volume 21,2018,Pages 782-789,ISSN 2351-9789.