

Women Entrepreneurs in Circular Bio-economies

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Abstract

Women entrepreneurship is an inherent part of management compositions that stakeholders employ extensively to decipher ecumenical challenges. Given the status, the question occurs what it takes to transform women into entrepreneurs, particularly in circular bio-economies, before exploiting the entrepreneurial opportunities available with circular bio-economies, the collective efforts needed in the women entrepreneurship sphere. Research in this course was conducted based on expert opinion using the total interpretive structural modelling (TISM) technique. It depicts the twelve elements along with their causal relationship in the digraph with bold and transitive links. The study reveals that the hierarchical structural framework (digraph) is divided into six layers and three components stand in the first position. They are pro-social behaviour, emotional attachment, quality family fabrications, whereas technology transfer is at the bottom of the model. Further, in MICMAC analysis, all the elements are classified into autonomous, dependent, driving and linkage headings. A proper enhancement of these variables can augment several functions of the stakeholders.

Key Words

Circular Bio-economy, Women Entrepreneurship, TISM, Pro-social Behaviour

Introduction

Looking at the present state of planetary boundaries, circular (take-make-reuse model) and bio-economic (bio-based products) industrial ecological concept needs to have a more innovative entrepreneurial approach to it (Falcone et al., 2020; Røste et al., 2017; Sołtysik et al., 2019). The deliverables such as innovative circular business model designs (Lewandowski, 2016; Linder & Williander, 2017), commercialization of bio-based products (de Jong et al., 2012), R&D investments (Hetemäki et al., 2017), valorization of waste (Zabaniotou & Kamaterou, 2019) and the building of solid value-chains (Lokesh et al., 2018), all demand the enthusiastic participation of entrepreneurs at regional and national levels. To attain the same, the role of women entrepreneurs can be crafted and designed (Arisi, 2020) to accomplish a sustainable circular bio-economic edge (Baublyte et al., 2019).

In this milieu, the question arises: what are the deciding components that transform a young female into a successful entrepreneur in a circular bio-economy? And do any causal relationships exist among the elements responsible

for building women entrepreneurs in circular bio-economies? Is it realistic to categorize which factors are driving the other variables and which are mere linking variables?

Apart from that, circular bio-economies offer enough economic, social, political, and environmental opportunities to women entrepreneurs (Grundel & Dahlström, 2016; Loizides et al., 2019; Stratan, 2017). Though, it is a complex argument to win for all the stakeholders at present, research in this direction would make prospective female entrepreneurs, educators, practitioners, and government organizations realize their potential circular bio-economy. All together can give the required attention to the field that has a glorious future for entrepreneurship. A total interpretive structural modelling is used to recognize, retrieve, and acknowledge the determinants responsible for making women entrepreneurs in the circular bio-economy. The explanation of the model proposed using total interpretive structural modelling clearly defines the relationship among variables. The literature plus the experts justified and backed it. Therefore, the significant relations in the matrix strongly support the theme that is picked up in the present article.

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A relational digraph is prepared that shows prominent causal relations between variables based on expert opinion. The panel of experts is from the academic and practical world, having rich experience of over 15 years. The digraph is made using the initial and final reachability matrix representing bold and transitive links. Once the model is prepared, a few alterations were made in the relational digraph after consulting experts again. The present research can be of enormous potential to entrepreneurs of circular bio-economy. The determining factors for women entrepreneurs in the circular bio-economic setup can open immense scope for other practitioners and governmental organizations to create an entrepreneurial ecosystem focusing on women of their countries.

This article is organized as follows: The second section represents the systematic literature review of the determining factors of women entrepreneurship in circular bio-economy ending with the significant remark. In the third section, the research methodology of TISM is discussed, followed by the results, findings, and discussion in the next segment. The article concludes with the future scope of works and the limitation of the study.

Literature Review

The tremendous amount of circular bio-economy literature investigates different waste recycling bio-refinery strategies for developing sustainable blueberry (Liu et al., 2021) by reducing BCR (blueberry crop residues), managing olive cake supply chains (Raimondo et al., 2021), microbial recycling e-waste by restoring copper and gold (Ilyas et al., 2021) citrus peel waste extraction (Teigiserova et al., 2021) and many more. But a vast gap exists in the development of path-breaking innovative opportunities (Grillitsch et al., 2021), mainly under Schumpeter creative entrepreneurship (Shane & Venkataraman, 2000). Structural alterations and modifications in the type of the change agents (Mörner & Trippel, 2017) require greater attention from theoretical and practical perspectives. Innovative entrepreneurs are needed to create new opportunities (Neffke et al., 2018) by combining the existing knowledge base or combining two unknown knowledge sets. For regional growth, creative entrepreneurship and institutional entrepreneurs' contribution is a must where circular strategies can bring much needed institutional reformation in the system (Sotarauta & Suvinen, 2018). The new regional development path creation is focussed in our study where multiple stakeholders' expertise, competencies, resources, etc., are all pooled into one (Jolly et al., 2020). The renewal of old industries or establishment of new industries depends on the vision and guidance of sustainable leadership (Antikainen et al., 2017). The immense scope for developing potential leadership in circular bio-economies is undebatable. Less emphasis is paid on the micro-factors compared to the macro and meso factors responsible for

sustainable administration (Vanhamaki et al., 2019) at the regional and national levels (policy makers). Thus, structural maintenance (reproducing existing structures) by entrepreneurial opportunity creation and exploitation (Martin & Sunley, 2006) is needed to successfully transform linear economies into circular bio-economic ones.

The lack of theoretical and practical standpoint of women entrepreneurship in circular bio-economies made us choose this theme for further study. The present research is built based on a realistic perspective (paradigm-shared knowledge/beliefs) (Creswell & Poth, 2016) of women working in 'Auroville'—the world-renowned sustainable township in Southern India, help us identify the circular bio-economic determinants. Many other micro-entrepreneurs extract partial or complete waste recovery value, and the females were single-handedly managing bamboo-based production in Andaman island. Given below, the circular bio-economic determinants are elaborated for the journal's audience.

Green Brand Evangelism

Dolan and Scott (2009), in their research undertaken in South Africa, Avon cosmetic organization, have underscored the function of evangelism, particularly pointing lipstick sales. To secure financial empowerment, being socially responsible for black women is intended by women entrepreneurs of linear economies back then. The book titled 'Preacher Woman Sings the Blue' is another work of authors where African-American evangelist's autobiographies are exhibited (Douglass-Chin, 2001). However, in the present times to accomplish proselytization for green and circular products, the value chain actors' participation needs to be amended by approaching more local women, thus growing their share in income and investments focusing on circular bio-economic activities (Palahi et al., 2020). The surge in women consumers, women producers, women suppliers, young women scientists, STEM-intensive women educators and trainers et al. can advocate the concept of green brand evangelism (Loizides et al., 2019). Therefore, fostering the role of local ladies and women entrepreneurs in circular bio-economy remains hugely neglected in both the developed and developing markets.

Valorization

'Social role valorization' and women are the two sides of the same coin that have been discussed in prior research work of many authors (Race et al., 2005; Wolfensberger, 2000). The women's role and distinctiveness in the community have always been at the forefront. However, in circular bio-economy, waste (food waste, solid municipal waste, forestry waste) recovery and valuation have limited involvement as a leader and entrepreneur. They most likely restrain it to the coffee processing, halieutic products

(Kebe et al., 2019) and waste valorization products following fermentation treatments (Hussain et al., 2020; Paul et al., 2014). While, waste treatment businesses mostly implicate women into background activities of turning waste into gold (Ravi et al., 2020), for instance, valorization of chicken feather waste, fruits and vegetables, agricultural bio-organic waste, etc., (Farag et al., 2020) but their substantial role is debatable and women as venture owners are few to find. The ample scope and entrepreneurial opportunities need to be exploited by women (change agents) so that their progress does not get jammed (Rosca et al., 2020).

Knowledge Transfer

Today, the information transmission of circular products, processes, and procedures has been labelled as a complicated system described under global value chain theory—a firm foundation of circular bio-economy (Gregg et al., 2020). The women's proportion and engagement in contrast to their male counterpart are less in circularly oriented organizations. Even they lack in business operating capabilities and skill-sets responsible for the information transmission (Marlow & McAdam, 2013). Digitalization, social media information sharing, network collaboration at regional levels, community services, STEM education, etc., all are being categorized into personal and organizational factors responsible for knowledge transfer, and women are best in the above-cited examples (Asiah et al., 2020; Nuaimi & Jabeen, 2020). However, they have to upgrade themselves to become a successful entrepreneur.

Pro-social Behaviour

The researchers Setini et al. (2020) have discovered that women entrepreneurs have little access to financial capital in comparison to social capital (community networking). So their admittance to information and its sharing is excellent personally and professionally. Men or women who behave more pro-social in the circumstances is difficult to conclude as per psychologists. To achieve circularity, women entrepreneurs need to have pro-social behaviour because the communal feelings (collective organizing) can strongly enable the ladies to opt for a closed-loop of resources and information (Kamas & Preston, 2020; Weston et al., 2020). Behaviour that endorses bio-based products instead of fossil products stems from green self-identity, self-congruity and perceived value (Confente et al., 2020). Pro-social behaviour (behavioural changes—less egoistic motivations/consumption behaviour) in context with the circular bio-economy itself is at the naïve stage (Koistila, 2020). The focus on women entrepreneurship in this domain is to pick up the required pace for a successful endeavour. Cross et al. (2020) show that it has a generalized effect on the person instead of the restricted one.

Building Micro-Entrepreneurs

Women entrepreneurs have to repeat the history by echoing the triumph of the micro-funding of start-ups/ small business (Maponga, 2018; Shahid et al., 2017). In this case too, women are the intrinsic part of the circularity model, that is, take-make-use-reuse (Haddadi, 2020). However, they are not driving the bus, which they should do to strengthen the development of women micro-entrepreneurs in their locality or region and increase their count (Schröder et al., 2020). The financial, social, economic, cultural, and political empowerment of women is attainable by following the nine circularity principles (Pavel, 2018) (reuse, refuse, refurbish, recycle, reproduce, reduce, replace, rethink, remanufacture). Eventually, resulting in an increased Gross Domestic Product (GDP) of economies (Apostolopoulos et al., 2018; Fackelmann et al., 2020). Women-oriented entrepreneurial policies should in place that can facilitate micro-women entrepreneurs to thrive; otherwise, the dearth of resources and regulatory measures can burn their desire to work for the community (Inman, 2016). The building of a contributory entrepreneurial eco-system (Neumeyer et al., 2019) in the circular bio-economic region for females is dismaying. However, the concerned authorities can not overlook it.

Emotional Attachment

The world demands entrepreneurial superwomen to protect the mother earth and the communities (Byrne et al., 2019). Women entrepreneurs can construct emotional businesses with a strong meaning annexed with it (Lewis, 2017). That means money making, besides having zero side effect on the environment even without pushing planetary boundaries, can lead to successful women entrepreneurship. Females have the upper hand in the emotional quotient area (Kundu, 2020). Emotions with the craft, with the results, process, precisely with the innovative circular bio-economic business models lead to win-win solutions to the women-oriented organizations (Webster, 2020). As per researchers Ranjitha Bernice & Jebaseelan, 2017, emotional energy resonates with the like-minded people willing to contribute to the value addition process of circular and bio-economic functions (Saini & Agarwal, 2020). Based on the researcher's observations and studies, the neuropsychological angle needs to be examined for each entrepreneur irrespective of their gender.

Intrusive Thoughts

Researchers have detected a substantial divergence between normal and intrusive thoughts (anxiety, fear, suicidal thoughts, inability to enjoy life) in context to entrepreneurial competencies. The women dealing with the mindset filled with intruding thought process can often take them in another direction from the routine life. The present domestic and professional atmosphere has a lot to offer to shape their psychology. For instance: discontented with the salary/wages, working culture,

imbalanced work-life scenario, resource wastage, labour exploitation, government HR laws and regulations, environmental issues, social unacceptance, etc. all help to shift their focus on the entrepreneurial side than continuing with their present jobs (Lokeshwari & Rajeswari, 2020; Shahriar & Shepherd, 2019). The negative thoughts and feelings coerce them to move towards their roots and inner preferences, leading to conceptualizing entrepreneurial opportunities and exploitation.

As per an academician in the panel, 'The fear of failure and violence at home force women to move towards entrepreneurial activities or things of their own choices.'

As per another academician, Intrusive socio-cultural thoughts like lack of family support and restrictions at home can force them to become a necessity-based entrepreneur.

Open Innovation in R&D

The innovation, investment in R&D, development of new skills, new circular processes and products etc., are all found at the core of the circular bio-economic concept (Hetemäki et al., 2017). Previous researchers reveal how extracting commercial value from agricultural waste requires continuous R&D and open innovations, particularly with circular economies (Iversen et al., 2019). Entrepreneurship is synonymous with creative destruction that is exploited for economic, social, and ecological returns. Making R&D gender-specific would be difficult because women are equally innovative as their counterparts (Díaz-García et al., 2013). The women entrepreneurs rank innovation at the top for all the business and making it the heart of circular bio-economy need to be checked.

Family Fabrications (Personal Interviews)

The women entrepreneurs conducted personal interviews by scanning all the family details of the employees to enhance their interest and trust in them (Lenka & Agarwal, 2017). Even the feeling of oneness arises as the women can resonate with the other lady members of the family. Over and above, it is observed in the literature of entrepreneurship, that feelings and affinity within groups/teams positively affect the venture operations and their successful implementation (Bogoviz et al., 2020). The interviewer selecting a candidate based on his/her details rather than education qualification has been observed in many entrepreneurial firms. The women entrepreneurs connect more on the individual level because of their familiar roles and identities (Alshawaf, 2020). The feeling of empathy becomes the point of selection than the other parameters of job selection. How true it will be with a circular bio-economic setup because of resource constraint. The topic is in the development stage and does the same argument hold in this perspective? To further simplify the topic, we mention below, a few instances of the questions that are usually asked in real-life situations:

The questions like

How many working family members do you have? Do you have any alcoholic problems or any other unpleasant habit? The number of children you have? What motivates you to join this organization? What innovative ideas can you bring to solve the socio-environmental problems? How will you protect the depleting village culture and local resources?

They ask the basic personal questions to know more about his/her family structure and income sources rather than the job experience and degrees.

Technology Transfer in Training & Development

The small entrepreneurial firms operating in circular bio-economy have various challenges in obtaining technological infrastructure and services. Multiple problems ranging from trained resources, pricing, accessibility, governmental regulations etc., are all part of it (Audretsch et al., 2016).

One practitioner stated that *at present, technology transfer is not even on their mind because we are still figuring which one is most suitable to us*. Technology is essential, but its transfer has been done internally without including the external bodies.

Another one stated: *Technology transfer at free of cost would be difficult as we have to sustain and arranging for external people to brain drain session at this level is challenging*.

The third expert reveals: *The ideas to protect the environment and the resource bank in one locality might not be exact at some other place. So, technology transfer might not benefit the people representing other localities*.

Women entrepreneurs have to deal with this challenge, and resource allocation in this direction should be a part of their business plan.

Extreme Patriotism

The extreme patriotism highlights that one is concerned too much with his/her country and has a special feeling for their motherland and mother language. The patriotic immigrants share close relationships with their community people, driving them to take up entrepreneurship (Brzozowski, 2020). We see a couple of examples where women entrepreneurs have kept country first over other things, even in the foreign land.

One practitioner said, 'We want to serve our country with the regional resources.'

An academician says, 'Privatization no doubt has disturbed the sustainable way of living that people had earlier.'

Few women entrepreneurs have less exposure and bound to work within the country boundaries. It is essential to check their preference outside the country. The traditions, culture, beliefs, attitude of communities also make women entrepreneurs more patriotic (Bunagan & Sison,

2020). The pass-on of the ideology from generation to generation makes women closer to their roots.

The major takeaway based on the above discussion is that very few management theories like global value chain, social identity theory perspective (Benito et al., 2019; Stets & Burke, 2000) etc., are noted. Most narratives are from an industrial ecological perspective that includes entropic biosphere theories referring to the change of order from one state to another (D'amato et al., 2019). However, primarily focussing on entrepreneurship, there is no such narrative discussed presently that closely defines the gender-specific entrepreneurial activities in the circular bio-economy. Natural-resource-based view theories have been discussed in most of the research papers based on sustainability (Hart, 1995). The efforts to study the circular bio-economic concept through the managerial lens need to increase from the management scholarly world.

Research Methodology

Qualitative Structural Modelling

The qualitative approach is used to gather the data via a structured interview method (Qu & Dumay, 2011) and inductive reasoning (Ketokivi & Mantere, 2010) when an unknown phenomenon is explored or a previously researched theme is looked at from a fresh perspective (Thomas, 2006). The qualitative modelling technique is used to draw the hierarchical structure of the variables retrieved from the literature and after taking the experts' standpoint. The researchers widely use this technique to understand the contemporary subject, and it is popularly called TISM (total interpretive structural modelling). TISM depicts the contextual relationship between the variables, popularly called the advanced version of the ISM (interpretive structural modelling) (Jayalakshmi & Pramod, 2015). The TISM method helps in structural-model building to simplify the complex theme of circular bio-economy. The model reflects the direct and transitive (indirect) links purely reflecting the experts' views on the topic. It can further categorize the model's elements in the dependent, autonomous, driving, and linkage departments. That is labelled as MICMAC analysis. MICMAC is used to examine the relationship between significant determinants of women entrepreneurship in circular bio-economy based on their driving and dependence power (Mandal & Deshmukh, 1994). This research characterizes the identification and benchmarking of the determinants and their relationships. TISM involves a set procedure where the following matrix and graphical representation of the model are done: VAXO table, initial reachability matrix, final reachability matrix, level of partition, iteration model, interactive matrix and digraph (bold and transitive links) (Sushil, 2017).

We carry the total imperative structural modelling method in the article to determine the hierarchical framework (Jena et al., 2017) of the determining factors of women entrepreneurship in circular bio-economy. By

retrieving twelve factors from the literature that will help the field of entrepreneurship, here an attempt is made to further narrow down the number by taking expert opinion. The thematic content analysis is used to analyse the interviews and factors responsible for the evolution of women's entrepreneurship literature. The 12 variables are:

1. Green Brand Evangelism (GBE1)
2. Valorization (VA2)
3. Knowledge transferring (marketing of concepts and ideas not products/ delivering value)—(KT3)
4. Prosocial behaviour (PB4)
5. Building of microentrepreneurs—Financial independence (Entrepreneurs building micro-entrepreneurs) (BME5)
6. Emotional attachments (EA6)
7. Intrusive thoughts (upsetting thoughts towards present HRM)—(IT7)
8. Circular bio-economic perspective (CBP8)
9. Open innovation in R&D (R&D9)
10. Scanning emotional quotient personal interviews (no professional degrees required) scanning quality fabrications (family structures) (QF10)
11. Technology transfer in Training & Development (TT11)
12. Extreme patriotism (EP12)

To explore the relationship between 12 variables, a questionnaire approach was applied (McClelland, 1994). The study's theme and demographic content were included, which is floated in the academic and practitioners world to make the questionnaire approach more effective. On the spot, questions were added as and when required (Taherdoost, 2016).

We selected seven experts from the academic world with a firm grip on the subject for the analysis and validation of the identified variables and structural building, followed by the nine practitioners running successful circular-bio-economic enterprises (10 agreed). A few eminent names of practitioners such as Dr Shiv Darshan Malik, Mr Maher Singh and Mr Binod Ganguly, who have given a real insight into circular bio-economic firms' functioning, are mentioned for the audience. All are based in India but have either taught or worked globally. As the theme is naïve and managerial theories supporting this narrative are less, so academicians have less contributed to the topic. Despite that, their viewpoint has helped in upgrading the ultimate model resulted from the study.

Further to develop the TISM model, it takes the following steps:

Step1: At last, ten analysts representing both the worlds of academics and practice were called personally. Their opinion recorded, after which, based on discussion and literature, twelve variables were selected and frozen for the study.

Step 2: Based on our discussion and dialogue, the first table that is structural self-interaction was formed, also popularly known as VAXO matrix (when the row factor leads to column factor, then V; when both lead to each other then X, when column factor leads to row factor then A; no relation then O). The influential factors and interpretations defining the link status were all planned based on expert judgement.

Step 3: After VAXO, Table 2 depicting the alphabets' binary state was created called initial reachability matrix where $V/X = 1$ and $A/O = 0$. The final reachability matrix using transitive law ($A = B$; $B = C$; $A = C$) is made that rectifies the data set, and finally, this data is used for further calculations.

Step 4: Level partition of the data is done based on reachability and intersection set for which antecedent set is used. Thus, different levels are calculated, and at one level, multiple variables can be located.

Step 5: The digraph based on Tables 4 and 5 is made, and to figure out a transitive link, another table is formed (interaction Table 6). The weak relation between variables can be overcome by using transitive data. Therefore, eventually, a digraph of dotted and straight lines are depicted using the TISM technique.

Step 6: For the audience, the variables are further divided into different headings like autonomous, driving, dependent, and linkage variables. That relies on the dependence and driving power calculated in Table 3 that is 93.

Results and Discussions

This study answers the following research questions. What are the determining variables responsible for women entrepreneurship in circular bio-economies? We have carried out structured interviews of experts to identify the

variables and their interdependencies. Also, how various determining variables interact with one another and how they lead to women entrepreneurship. We also discussed determinants under MICMAC analysis based on their dependency and driving powers.

In the article, the discussion of the results appear in two contexts: (a) bold links (b) transitive links elaborated separately for the journal's audience.

- A) **Bold Link:** The bold link establishes the direct relationship between variables using pair-wise comparisons in Table 1. (VAXO) Table 2 (initial reachability matrix—binary form). We can see a graphical depiction of the digraph into six levels in Figure 1. The variable number eleven technology transfer is at the bottom of the hierarchy, taking the sixth position. And variable four (pro-social behaviour), six (emotional attachment) and ten (quality family fabrications) at the first level. The determinants at the hierarchy's top are the most crucial variables of women entrepreneurs looking to work in circular bio-economy and vice versa. A single-headed arrow depicts a one-way relationship, and double-headed pointers have a two-way relationship between variables to show the relationship type. For instance: building micro-entrepreneurs lead to pro-social behaviour, but a circular bio-economic perspective leads to the building of micro-entrepreneurs. All the variables retrieved from the literature do share a relationship but attached at different degrees of importance.
- B) **Transitive Link:** The superlative transitive link means the relation which is been ignored by the ISM (interpretive structural modelling) technique, then the hidden links are brought to the surface using the TISM (total interpretive structural modelling) technique. We depict the graphical representation of Tables 3 and 6 that has helped figure out the transitive links (based on expert opinion) between variables in the digraph using dotted lines.

Table 1. Structural Self-interaction Matrix (VAXO)

Variables (j) (i)	EP I2	TT I1	QF I0	R&D9	CBP8	IT7	EA6	BME5	PSB4	KT3	VA2	GBE1
GBE1	X	A	X	A	X	X	V	A	V	V	V	
VA2	X	A	V	A	V	A	V	X	V	A		
KT3	V	V	V	V	V	X	V	V	V			
PSB4	A	A	V	V	A	A	O	V				
BME5	A	A	O	A	X	A	O					
EA6	V	V	X	O	A	A						
IT7	V	V	O	V	V							
CBP8	V	A	V	A								
R&D9	A	X	O									
QF10	X	O										
TT11	A											
EPI2												

Source: The authors.

Table 2. Initial Reachability Matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12
GBEI	1	1	1	1	0	1	1	1	0	1	0	1
VA2	1	1	0	1	1	1	0	1	0	1	0	1
KT3	0	0	1	1	1	1	1	1	1	1	1	1
PSB4	0	0	1	1	1	0	0	0	1	1	0	0
BME5	0	1	1	1	1	0	0	1	0	0	0	0
EA6	1	0	0	0	0	1	0	0	0	1	1	1
IT7	0	0	0	0	1	0	1	1	1	0	1	1
CBP8	1	0	0	1	1	0	0	1	0	1	0	1
R&D9	0	1	1	1	0	0	1	1	1	0	1	0
QF10	0	1	0	1	0	1	0	1	0	1	0	1
TT11	0	1	1	1	0	1	1	1	1	0	1	0
EPI2	0	0	0	1	1	1	1	1	0	1	0	1

Source: The authors.

Table 3. Final Reachability Matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	Driver Power
GBEI	1	1	1	1	0	1	1	1	0	1	0	1	09
VA2	1	1	0	1	1	1	0	1	0	1	0	1	08
KT3	0	1*	1	1	1	1	1	1	1	1	1	1	11
PSB4	0	0	1	1	1	0	0	0	1	1	0	0	05
BME5	0	1	1	1	1	0	0	1	0	1*	0	1*	07
EA6	1	0	0	0	0	1	0	0	0	1	1	1	05
IT7	0	0	0	1*	1	0	1	1	1	0	1	1	07
CBP8	1	0	0	1	1	0	0	1	0	1	0	1	06
R&D9	0	1	1	1	1*	0	1	1	1	1*	1	1*	10
QF10	0	1	1*	1	0	1	0	1	0	1	0	1	07
TT11	0	1	1	1	1*	1	1	1	1	1*	1	1*	11
EPI2	0	0	0	1	1	1	1	1	0	1	0	1	07
Dependence Power	04	07	07	11	09	07	06	10	05	11	05	11	93

Source: The authors.

Note: 1* stands for transitivity.

Table 4. Level Partitions

Variables	Reachability Set	Antecedent Set	Interaction Set	Level
GBEI	1,2,3,4,6,7,8,10,12	1,2,6,8	1,2,6,8	I
VA2	1,2,4,5,6,8,10,12	1,2,3,5,9,10,11	1,2,5,10	
KT3	2,3,4,5,6,7,8,9,10,11,12	1,3,4,5,9,10,11	3,4,5,9,10,11	
PSB4	3,4,5,9,10	1,2,3,4,5,7,8,9,10,11,12	3,4,5,9,10	
BME5	2,3,4,5,8,10,12	2,3,4,5,7,8,9,11,12	2,3,4,5,8,12	
EA6	1,6,10,11,12	1,2,3,6,10,11,12	1,6,10,11,12	I
IT7	4,5,7,8,9,11,12	1,3,7,9,11,12	7,9,11,12	
CBP8	1,4,5,8,10,12	1,2,3,5,7,8,9,10,11,12	1,5,8,10,12	
R&D9	2,3,4,5,7,8,9,10,11,12	3,4,7,9,11	3,4,7,9,11	
QF10	2,3,4,6,8,10,12	1,2,3,4,5,6,8,9,10,11,12	2,3,4,6,8,10,12	
TT11	2,3,4,5,6,7,8,9,10,11,12	3,6,7,9,11	3,6,7,9,11	I
EPI2	4,5,6,7,8,10,12	1,2,3,5,6,7,8,9,10,11,12	5,6,7,8,10,12	

Source: The authors.

No doubt, the concept of women entrepreneurship in circular bio-economy is becoming a subject of dialogue for practitioners, entrepreneurs, policy-makers, and managers. The building of circular bio-economic women entrepreneurs is possible only through the creation of entrepreneurial eco-

system following circularity principles and managerial theories. But the problem is whether the management narratives and countries resource bank suffice to back the women entrepreneurs looking to thrive in this field. The present article identify, accept, and quantify the various factors

Table 5. Partitioning of Variables Iteration I

Variables	Reachability Set	Antecedent Set	Interaction Set	Level
GBE1	1,2,3,4,6,7,8,10,12	1,2,6,8	1,2,6,8	V
VA2	1,2,4,5,6,8,10,12	1,2,3,5,9,10,11	1,2,5,10	IV
KT3	2,3,4,5,6,7,8,9,10,11,12	1,3,4,5,9,10,11	3,4,5,9,10,11	V
PSB4	3,4,5,9,10	1,2,3,4,5,7,8,9,10,11,12	3,4,5,9,10	I
BME5	2,3,4,5,8,10,12	2,3,4,5,7,8,9,11,12	2,3,4,5,8,12	II
EA6	1,6,10,11,12	1,2,3,6,10,11,12	1,6,10,11,12	I
IT7	4,5,7,8,9,11,12	1,3,7,9,11,12	7,9,11,12	III
CBP8	1,4,5,8,10,12	1,2,3,5,7,8,9,10,11,12	1,5,8,10,12	II
R&D9	2,3,4,5,7,8,9,10,11,12	3,4,7,9,11	3,4,7,9,11	V
QF10	2,3,4,6,8,10,12	1,2,3,4,5,6,8,9,10,11,12	2,3,4,6,8,10,12	I
TT11	2,3,4,5,6,7,8,9,10,11,12	3,6,7,9,11	3,6,7,9,11	VI
EPI2	4,5,6,7,8,10,12	1,2,3,5,6,7,8,9,10,11,12	5,6,7,8,10,12	II

Source: The authors.

Table 6. Interaction Matrix (Binary Matrix)

Variables	1	2	3	4	5	6	7	8	9	10	11	12
GBE1	–	1	1	1	0	1	1	1	0	1	0	1
VA2	1	–	0	1	1	1	0	1	0	1	0	1
KT3	0	1	–	1	1	1	1	1	1	1	1	1
PSB4	0	0	1	–	1	0	0	0	1	1	0	0
BME5	0	1	1	1	–	0	0	1	0	1	0	1
EA6	1	0	0	0	0	–	0	0	0	1	1	1
IT7	0	0	0	1	1	0	–	1	1	0	1	1
CBP8	1	0	0	1	1	0	0	–	0	1	0	1
R&D9	0	1	1	1	1	0	1	1	–	1	1	1
QF10	0	1	1	1	0	1	0	1	0	–	0	1
TT11	0	1	1	1	1	1	1	1	1	1	–	1
EPI2	0	0	0	1	1	1	1	1	0	1	0	–

Source: The authors.

Note: Bold: Direct link; Yellow Italics: Transitive link.

responsible for making circular bio-economic women entrepreneurs, where direct, indirect and zero relation between variables are figured out that leads to women entrepreneurship.

From the MICMAC analysis of Table 7, we divide the factors into four themes and making it easier for the practitioners to focus on the driving, dependent, autonomous, and linkage variables. Maximum linkage factors like extreme patriotism, the building of micro-entrepreneurs, valorization, knowledge transfer and quality family fabrications (PIs) are highlighted because they have both driving and dependence characteristics with each other. That brings the focus to not only women entrepreneurs but also to educators, practitioners, and policy-makers—the crucial elements of circular bio-economies. At the initial stage itself, young girls and women can be groomed based on the findings and results. The main driving variables like technology transfer, intrusive thoughts, green brand evangelists, and R&D highly facilitate women's entrepreneurial ecosystem growth. Though no independent variables are extracted in the study, the dependent variables like emotional attachment, pro-social behaviour, and circular

bio-economic perspectives have high dependency power on other variables but no driving power. Also, the TISM technique establishes the significant relationships of variables that steer women entrepreneurship. For instance, technology transfer increases the number of micro-entrepreneurs in the country, followed by the increased intake of personnel in the organization based on their interviews. Another variable like intrusive thoughts of entrepreneurs towards the present work culture and greedy organizations being least sensitive towards the environment and society can influence the entrepreneur's perspective (pro-social behaviour). Thus, it can easily be concluded that pro-social behaviour, emotional attachment and family fabrication (PIs) all play the dominant role in the making of women entrepreneurs.

At level two in Figure 1, all three variables showcase how extreme patriotism, drive to build micro-entrepreneurs, and circular bio-economic perspective can enhance the number of women in taking up entrepreneurial activities focusing on closed loops of resources and information. One of the significant contributions of the study is that

Table 7. Clusters of Variables Responsible for Circular Bio-economic Women Entrepreneurship (MICMAC Analysis)

Driving	12	TT11 DRIVING VARIABLES (IV) GBE1, R&D9 IT7	LINKAGE VARIABLES (III) BME5 QF10 EPI2, KT3, VA2
	11		
	10		
	09		
	08		
	07		
Power	06	AUTONOMOUS VARIABLES (I)	CBP8 EA6 PSB4 DEPENDENT VARIABLES (II)
	05		
	04		
	03		
	02		
	01		

Dependence Power

Source: The authors.

intrusive thought at level 3 gives rise to three prominent factors that are the backbone of the women's entrepreneurship. The feeling of dissatisfaction with the current surroundings opens up bigger avenues for women personally and professionally. Interestingly, the waste valorization activities and value creation often suppress the intrusive thoughts that women have towards the present situations. The inner feelings and emotions change proportionally with the benefits derived from the waste.

Therefore, the TISM model validates the women entrepreneurial variables that are and would play an immensely decisive role in shaping the field of entrepreneurship from the managerial perspective.

Apart from Figure 2, the other key findings of the study are listed below. The following measures can help women entrepreneurs rise in society and professionally they could contribute more to the building of local communities and sustainable organizations.

- The Indian government's focus on building sustainable women's leadership through SISFS (Startup India Seed Fund Schemes' 2021) is one big step towards increasing women entrepreneurship in circular bio-economies. The government will identify 300 incubators promoting 3,600 entrepreneurs, and they will distribute seed funds of 945 crores over the next 4 years. The women-centric micro-entrepreneurs can benefit at large from the above schemes. In return, they can add more women employees into their organization and thus enhance their standards of living.
- The association of women entrepreneurs with the UN's WEPs (Women's empowerment principles) can help reap more incredible benefits for women at the regional/local level (UN Women, 2020). The German MNC, like Covestro AG (leader of polymer solutions), with 23% female participation, has taken

this initiative for their female employees (Golling et al., 2019).

- To positively influence the mindset of women, some leading examples of HDI (Hasiru Dala Innovations); daily dump compost-bin at homes (Orbin) and Auroville-Upasana 'design for change' can act as a learning model for others willing to take up entrepreneurship in this domain.
- Recycling fashion, textile recycling processes (GOONJ), sustainable cosmetic fashion (Awake organics—UK) and many more are the initiatives that have female participation selected based on their family details rather than professional degrees. The feeling of being one of us can uplift the women's stature in the world.
- The constant disruptive innovations (de Araújo et al., 2020) traced in circular bio-economies by female entrepreneurs over digital space can help them become brand evangelists for other green products.
- Organizations (MNCs or domestic) should give the platform to the voice of women trying to recover waste value. They need to be encouraged because only through their efforts local community building (Bernhard & Olsson, 2020) can occur. Even to have a pandemic resilient society, women have to be in the mainstream of the entrepreneurial ecosystem.
- Research by Ellen MacArthur Foundation on gender equality in circular bio-economies (Pitkänen et al., 2020) can lay a path for other female academicians and researchers. They can discuss and help penetrate the information at the local/micro levels for young female entrepreneurs who have a zeal for tackling waste-related severity issues.

The tripartite involvement (government, entrepreneurs, and organizational) can help solve waste-related issues by

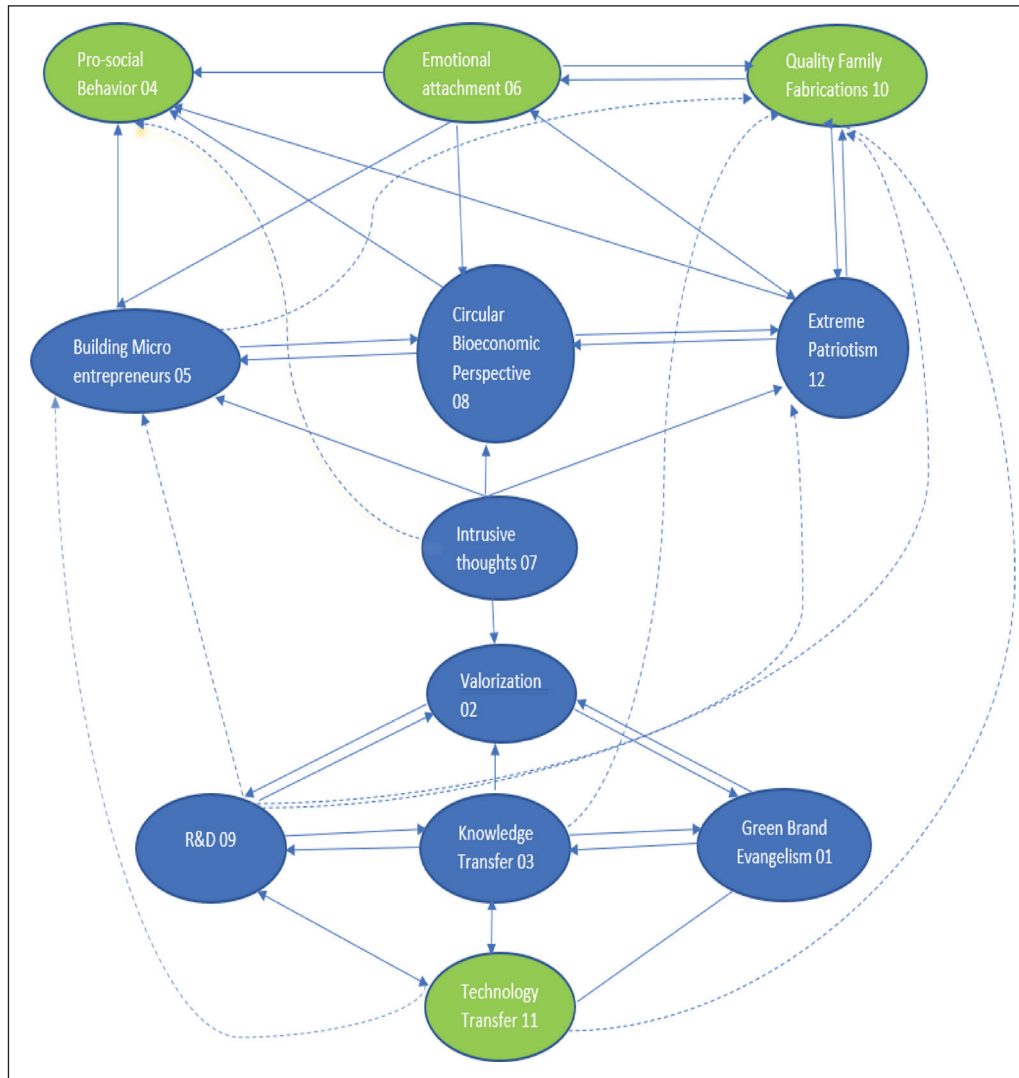


Figure 1. Digraph with Significant Transitive Links

Source: The authors.

providing entrepreneurs with seed funds (investments), learning models (key business drivers), commercialization options, experiences on shared platforms (knowledge sharing), associating themselves (networking partners) with the UN projects and schemes and many more (Figure 2).

Even the study will immensely contribute to the literature of circular bio-economies that lacks female entrepreneurial aspects. However, to get equitable and sustainable communities, the cities-policy instrumentation and its assessment models need to be robust and comprehensive. The substantial nexus of natural resources (water-food-energy) and entrepreneurial eco-system should be developed at each stage (micro, meso, and macro) using resource-mapping technique. The societies with excess resource beds can be exchanged for other resources of different areas. Women have the power to be change agents (Wong, 2020) and can quickly restructure society by

actively taking part in the workforce. Other social issues of gender inequality, marital problems (dowry), sexual violence, and many more can be uprooted once they become job-provider instead of job-seeker.

Conclusions

The transition from linear economies into circular economies, especially for the developing world, is not as easy as it seems. Gaining economic returns from these activities have more significant challenges, too, for practitioners and managers. Eventually, the world will move towards the circular bio-economic field's managerial activities because of planetary boundaries. From the management perspective, the women's role and contribution cannot be underestimated because they are equally capable of the economic growth of their country. The variables identified and

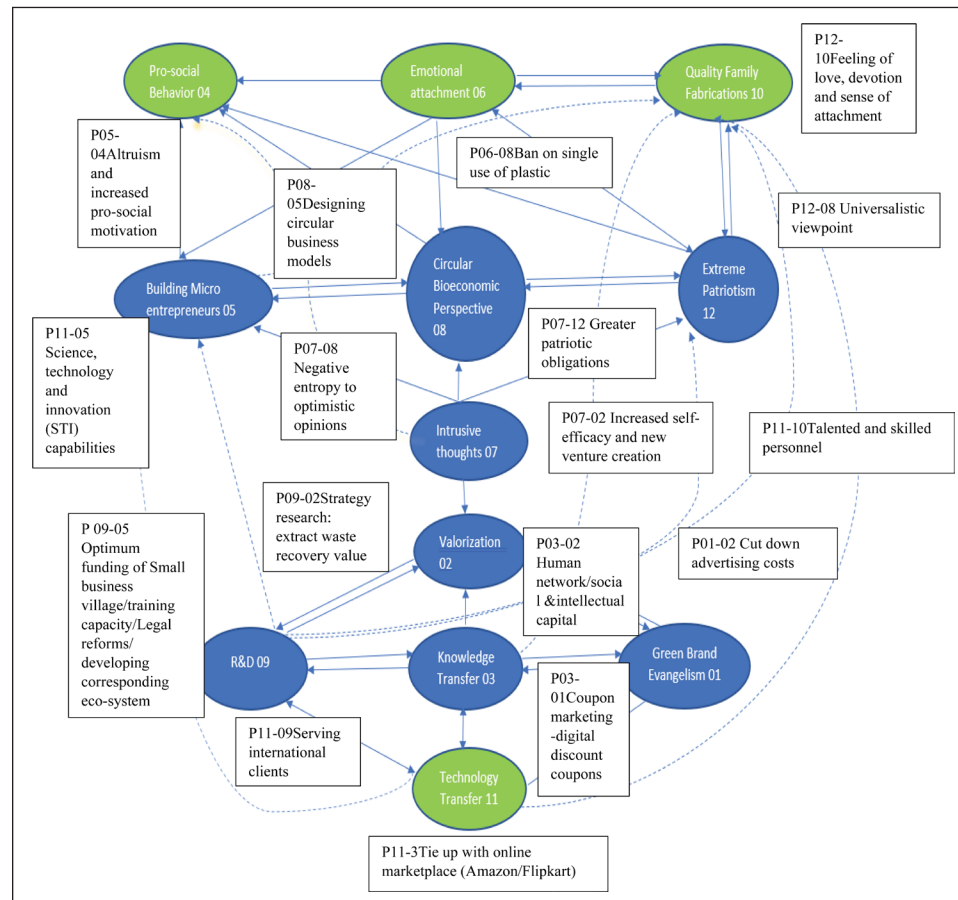


Figure 2. TISM Model of Determinants of Women Entrepreneurs in Circular Bio-economies (P stands for the path)

Source: The authors.

located under one roof can gain immense attention from the stakeholders that might remain unattended by most of them. The hierarchical framework of women's entrepreneurial determinants will further benefit them, as they can prioritize their efforts in this direction accordingly. Table 7 and Figures 1 and 2 are the guiding force and the decision changing parameters for the stakeholders that will give unmatched results.

Attention and efforts can be alternated and monitored as per the rankings and categorization among driving, dependent, and linkage themes. Educators and policy-makers can demarcate the institutions and innovation laboratories in their region having a greater count of women candidate and then streamline their curriculum as per the findings. Any gap in the present subject can be filled, and they can appoint even trainers who resonate with patriotism and have a circular bio-economic perspective. The male entrepreneurs can encourage women at home or at the workplace to develop their ventures. The participation of women in the value chain can focus more on these factors and identify with them, so they end up being the entrepreneur rather than being a mere employee. The industrial ecology and management researchers have to build on the concept because individual

theoretical attention is of no use unless the mass population gets benefit out of it. The academic world can empirically study the identified factors responsible for women entrepreneurship in the circular bio-economic world. Future researchers need to ask the more significant questions like, do the same factors apply to male entrepreneurs? If not, what do they share between them? The policies and regulations at the local level primarily focusing on the regional resources should be formulated. It should give the women, quota and benefits to lure them into feeling encouraged to take up these activities. Though the Indian government has done a lot, still ample scope remains in this direction.

Limitations and Future Work

Few limitations exist in the present article as some variables like emotional attachment, perspective, intrusive thoughts etc. are difficult to measure in practical terms. We recognize the experts and analysts within the country, so the global perspective is missing on the variables. Even transitive links just show the association between variables and extracting further information from them could be difficult. Future studies can have over 12 variables for complex

model building. Due to the lack of systematic literature review in the domain, future lessons can consider it besides having an expert opinion as one criterion for data collection. They should statistically validate the theoretical model using structured equation modelling. The in-depth case study method can be used for backing the arguments associated with women entrepreneurship in circular bio-economics. The generalization of results is not suggested because of changed geographical and demographic values. The researchers in future should cover the developing and developed economies separately.

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