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Linking green intellectual capital with green innovation: Examining the roles of green dynamic capabilities and 'motivation to achieve legitimacy'

*Denisa Bogdana Abrudan[1], Nosheen Rafi[2], Dana Codruta Daianu[3], Masood Nawaz Kalyar[4]**

[1]Management Department, Faculty of Economics and Business Administration, West University of Timisoara, East European Center for Research in Economics and Business (ECREB), Timisoara, Romania
[2]Department of Business Administration, Faculty of Management and Administrative Sciences, University of Sialkot, Sialkot, Pakistan
[3]Department of Economics, Faculty of Economic Sciences, Aurel Vlaicu University of Arad, Arad, Romania
[4]Lyallpur Business School, Government College University Faisalabad, Faisalabad, Pakistan

**Corresponding author: masood.kalyar@yahoo.com*

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Abstract: The present study aims to investigate the roles of agricultural firms' green dynamic capabilities (DCs) and 'motivation to achieve legitimacy' in the relationship between green intellectual capital (IC) and green innovation. We posit the 'resource-capability-outcome' model according to which green IC is an important strategic resource which helps firms to build and increase green DCs in order to achieve green innovation outcomes. The data were collected from 146 firms operating in both primary and secondary sectors. Partial least squares structural equation modelling (PLS-SEM) was used with WarpPLS 8.0 to process and analyse the data. The results indicated that green DCs serve as an important underlying mechanism and mediate the relationship between green IC and green innovation. Moreover, results also supported the moderating role of the firms' motivation to achieve legitimacy, implying that high motivation strengthens the relationship between green DCs and green innovation. However, the results did not support moderation for the relationship between green IC and green DCs.

Keywords: environmental degradation; green capabilities; pro-environmental performance; sustainability-oriented intangible assets

Environmental degradation is detrimental because of its harmful effects on ecosystems, especially on the health and well-being of humans, plants, and animals (Belaïd and Zrelli 2019; Chen et al. 2021). The protection of the environment is critical in order to diminish the destructive influence of anthropogenic activities on ecosystems. Therefore, it is more than a moral responsibility for humans to protect the environment from pollution and activities that contribute to its degradation. That is why governments, communities, firms, and experts are paying growing attention to processes and actions that may protect the environment from human activities in general, and from industrial activities in particular (Aini 2021; Borsatto and Bazani 2021). In particular, there is ample evidence on the substantial contribution of the agricultural sector to environmental deterioration and pollution. At the same time, many studies highlight the significance of actions that might be taken by firms to reduce pollutant emissions (Wang 2019; Bridhikitti et al. 2021). In this regard, they have postulated green innovation as a possible solution for environmentalism (Wang and Juo 2021). Green in-

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novation refers to the process that contributes to the creation of new products, processes, and technologies with the aim to reduce environmental risks. A recent review advocates that firms which embed green elements in product design and process development have a greater chance of success in terms of cost-efficiency, market performance, ecological reputation, energy saving, environmental performance, prevention of pollutant emissions, competitive advantage, and financial performance (Takalo and Tooranloo 2021).

Considering the importance and complexity of green innovations, the existing literature examined various factors that foster green innovation. For example, Abbas and Sağsan (2019) postulated knowledge management systems as a key driver of sustainable development and green innovation. From a knowledge management perspective and drawing on Chen (2008), a recent study of Wang and Juo (2021) offered a novel conceptualization of green intellectual capital (IC) – the total stock of sustainability-oriented intangible assets, information, and collective knowledge that create pro-environmental value for firms – and advocated it as an important driver of green innovation. The present study takes this into account but posits that green innovation is a complex process and involves interactions of various individual, organisational, structural, and contextual factors (Shally et al. 2004) to come up with successful solutions that protect the environment and promote eco-friendly products and processes. Given the complexity of innovation, it is expected that green IC tap into some important mechanisms to encourage green innovation, rather than IC being the primary source of innovation (Tsou and Chen 2020). Therefore, our study attempts to identify the missing link between green IC and green innovation. More specifically, we postulate green dynamic capability (DC) as the missing link and argue that it is an underlying mechanism through which green IC drives green innovation (Albort-Morant et al. 2016; Yousaf 2021).

The notion of green DCs refers to the firms' capability to integrate, construct, and reconfigure internal and external resources related to environmental protection (Qiu et al. 2020). This implies that green DCs are a firms' ability to respond proficiently to environment-related external changes through a combination of competencies, resources, and capabilities; and green IC determines that, when, how, and which existing resources, competencies, and capabilities should be exploited and/or new ones be explored in order to cater to environmental concerns. Green IC provides unique knowledge and a resource base which firms use to develop dynamic green capabilities. These green DCs make it easier for firms to construct, adjust and reconfigure structures and resources that help firms to prevent environmental degradation and ensure sustainability (Wang and Juo 2021). As noted earlier, green innovations require a unique resource base and competencies that are specific to environmental management practices. Therefore, green IC-induced green DCs are likely to promote green innovation (Tsou and Chen 2020; Singh et al. 2022).

In addition, it is also expected that the firms' propensity to use green DCs for green innovation is contingent upon contextual characteristics, such as the firms' motivation to achieve legitimacy (Tsinopoulos et al. 2018). As mentioned earlier, governments, societies, regulatory bodies, and institutions pressure firms to comply with environmental regulations, so the firms' motivation to achieve legitimacy seems to play a critical role in this regard. In simple words, the firms' motivation to achieve legitimacy, in terms of compliance with environmental regulations, moderates the effect of green IC in predicting green DC and the effect of green DC in fostering green innovation. In a nutshell, this study examines the mediating role of green DCs and the moderating role of the firms' motivation to achieve legitimacy in determining green innovation.

Literature review and hypotheses development

Linking green IC and green innovation through green DCs. The notion of green IC refers to the total stock of sustainability-oriented intangible assets, information, collective knowledge, experience, relations, learning and competencies that create pro-environmental value for firms (Chen 2008). Green IC is an overarching concept and comprises three facets: green human capital, green structural capital, and green relational capital. Green human capital encompasses the employees' accumulated knowledge, wisdom, skills, expertise, information and experience regarding environmental safety and protection (Chen 2008). Since firm-level performance outcomes depend upon the actions and achievements of individual employees, a highly motivated workforce is in turn likely to use its own wisdom, abilities and knowledge to innovate processes that ensure pollution control, save energy, and protect the ecosystem (Yusliza et al. 2020). Green structural capital is embedded in firms and includes a sum of patents, intellectual rights, databases, organisational climate and culture to achieve sustainability goals. It is also a sign of the firms' commitment, knowledge management systems, and managerial philoso-

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phies regarding environmental protection. The third form of green IC is green relational capital, which refers to the firms' 'accumulative interactive relationships with customers, suppliers, and partners about corporate environmental management and green innovation' (Chen 2008, p. 275). In short, all three facets of green IC taken together provide a pool of resources, processes, structures and interactive relationships to understand the importance of environmentalism and to enable organisational action toward green innovation.

The relationships between traditional IC and firm performance (including, competitive advantage, innovation, financial and environmental performance) are not new, and the literature maintains that resources such as employees, organisational culture, commitment, support, strategic intent, and strong ties with customers, suppliers and partners allow firms to successfully achieve strategic goals. However, these arguments and empirical inferences hold true for firms operating in stable business environments (Tsou and Chen 2020). Nevertheless, today's business environment is dynamic and most businesses are facing frequent changes in customer priorities, technology, market demand, supply networks, political and regulatory focus, and innovations in materials and manufacturing technologies (Qiu et al. 2020), which requires that firms redefine their resource base and core competencies to ensure survival and competitiveness. From this perspective, Magistretti et al. (2021) posited that innovation and performance-related outcomes need DCs to calibrate resources and adaptability to external changes to achieve strategic-fit. Therefore, it appears that although firms can promote green innovation through green IC, this relationship is not straightforward and denotes a missing link. In this regard, this study proposes that green IC promotes green innovation through some underlying mechanism such as green DCs.

Green DCs consist of the firms' capacity to learn, integrate and reconfigure organisational resources, structures and processes to add value to the firm while observing principles of environmentalism (Qiu et al. 2020). Customers' green consumption behaviour, strict environmental regulations, value congruity in the form of organisational isomorphism, changes in manufacturing technologies and materials force firms to acquire new knowledge, capabilities and to reconfigure current resources and internal knowledge to reduce pollution, waste and environmental degradation (Singh et al. 2022). Green DCs tap into firms' actions to develop organisational green capability and use green innovation in response to changes in the external environment. Thus, green DCs are advocated as a predictor of green innovation. In addition to that, firms must have the necessary resources and abilities for learning, integration, and reconfiguration (Magistretti et al. 2021). We postulate that green IC provides these necessary resources that trigger organisational action to develop green capabilities (Yusliza et al. 2020). For example, firms need to ensure the constant update of core competencies by using green IC so that these could not be easily copied by competitors and in order to add value to the firm in terms of increased sustainability and decreased environmental harm. In other words, green IC capital promotes the firms' green DCs which in turn drive green innovation. Hence, we hypothesize that:

H_1: Green DCs mediate the relationship between green IC and firm green innovation.

The moderating role of motivation to achieve legitimacy. Besides a consensus that firms engage in pro-environmental and eco-friendly actions for financial benefits, we postulate the firms' desire to be deemed legitimate by external stakeholders, which also motivates them to offer green products and adopt green processes. Firms reduce costs, save energy and protect the environment to seek financial benefits otherwise easily achieved through green innovation (Borsatto and Bazani 2021). However, when the firms' motivation is to achieve legitimacy, this involves a long-term commitment and redefining the business processes or even the entire business model in response to environmental risks. For instance, adherence to ISO 9000 improves quality and, at the same time, signals external stakeholders about the firms' compliance with some standards. Likewise, complying with international and domestic environmental regulations increases a firm's reputation in terms of environmental legitimacy (Tsinopoulos et al. 2018). Hence, the way firms desire legitimacy has an influence on their actions and processes towards green innovation. More specifically, the firms' high motivation to achieve legitimacy is likely to optimize the use of current resources and capabilities so as to embed green processes and offer green products (Wang et al. 2018). Thus, firms are expected to use their green IC optimally to develop green DCs. Likewise, the firms' desire to be seen as legitimate appears to motivate the management to increase green innovation by tapping into green DCs. Therefore, we posit that the firms' motivation to achieve legitimacy moderates the relationship between green IC, green DCs, and green innovation. Thus, it is hypothesized that:

H_2: The firms' motivation to achieve legitimacy moderates the relationship between green IC and green DCs.

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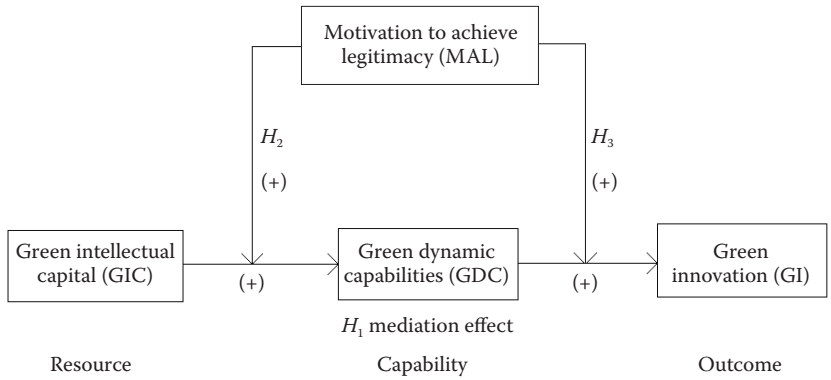

Figure 1. Proposed research framework

Source: Authors' own processing

H_3: The firms' motivation to achieve legitimacy moderates the relationship between green DCs and green innovation.

The proposed research framework is presented in Figure 1 which depicts graphical representation of proposed relationships among study variables.

MATERIAL AND METHODS

Data were collected through a structured questionnaire from the following 9 sectors: food processing, agricultural chemicals, textiles, leather, tobacco, restaurants, beverages, forest and wood products, and livestock and dairy. The respondents were top managers/owners of the firms. Since no comprehensive list of agricultural firms exists, the information regarding the respondent firms was obtained from various sources including professional networks, chambers of commerce and industries. The snowball sampling method was chosen. According to Bouckenooghe et al. (2015), this method is effective in contexts where a concrete sampling frame is not available. We chose firms that had been operating for at least five years and had ten or more employees. The reason to use age- and size-based criteria was to ensure the maturity of the respondent firms' knowledge management systems and resource structures (which firms try to achieve long-term strategic-fit in a dynamic environment) to respond to external changes because micro-firms and/or start-ups are usually less prone to environmental dynamism and external changes. Moreover, according to Wil Schroter (founder and CEO of Startups.com, a start-up platform that includes Clarity, Bizplan, Launchrock, Fundable, and Zirtual), it takes at least four years for a nascent firm to reach maturity in business as well as to build persistence in running it. A total of 211 firms were selected and the link to the online questionnaire was sent to the respondents. There was also a follow-up to the data collection process to increase the rate of response. We received 146 usable responses over a period of four weeks in February–March 2022. The sample distribution is presented in Table 1.

We used pre-developed questionnaires (scales) to measure study constructs and all responses were ob-

Table 1. Sample distributions

Sector	Respondent firms	Percent weight (%)	Accumulative weight (%)
Food processing	27	18.49	18.49
Agricultural chemicals	18	12.33	30.82
Textile	25	17.12	47.94
Tobacco	4	2.75	50.69
Leather	13	8.91	59.60
Restaurants	11	7.53	67.13
Beverages	8	5.48	72.61
Forest and wood products	17	11.64	84.25
Livestock and dairy	23	15.75	100.00
Total	146	100.00	100.00

Source: Authors' own processing

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tained on a 5-point Likert scale. An 11-item scale was adopted from Wang and Juo (2021) to measure green IC and was treated as a secondary latent construct as it comprises three dimensions: green human capital (3-items), green relational capital (3-items), and green structural capital (5-items). Green DC was measured using the 5-item scale of Lin and Chen (2017). Motivation to achieve legitimacy was measured by two items drawn on Tsinopoulos et al. (2018). Agricultural firms' green innovation was measured by a 5-item scale adapted from Wang and Juo (2021).

RESULTS AND DISCUSSION

The collected data were first analysed to ensure the validity and reliability of the study constructs by using WarpPLS 8.0 software. The results confirmed convergent validity, discriminant validity, and reliability [see electronic supplementary material (ESM); for ESM see the electronic version]. The correlation analysis shows that green IC has a positive correlation with green innovation (r = 0.262, P < 0.01) and green DCs (r = 0.451, P < 0.01) (Table 2). Moreover, results indicate that green DCs are positively linked with green innovation (r = 0.304, P < 0.01). The results provide initial support and suggest further analysis for hypotheses testing.

We performed partial least squares structural equation modelling (PLS-SEM) in WarpPLS 8.0 software (Figure 2). Warp3 was used as an inner model algorithm and bootstrap as resampling. The model-fit values presented in Table 3 suggest good fit indices. Since this study focuses on the mediating mechanism to reveal how green IC contributes to green innovation, we performed analyses using alternative models to see if mediation is present (Preacher and Hayes 2004). These initial analyses supported the presence of a mediation effect. Results shown in Table 3 indicate that green IC is a significant and positive predictor of green DCs [β = 0.43, standard error (SE) = 0.062, P < 0.01]. Results also show that green DCs are positively linked with green innovation

Table 2. Correlation coefficients and square-roots of AVEs (n = 146)

Constructs	GI	GDC	MAL	Firm age	Firm size
GIC	(0.820)	–	–	–	–
GI	0.262**	(0.847)	–	–	–
GDC	0.451**	0.304**	(0.830)	–	–
MAL	0.294**	0.155*	0.223**	(0.872)	–
Firm age	0.025	–0.020	–0.025	0.131	–
Firm size	0.124	0.114	0.069	–0.125	–0.081

*, **P < 0.05 and P < 0.01, respectively; GIC – green intellectual capital; GI – green innovation; GDC – green dynamic capabilities; MAL – firms' motivation to achieve legitimacy; square-roots of average variances extracted (AVEs) are on diagonal in parenthesis

Source: Authors' own processing

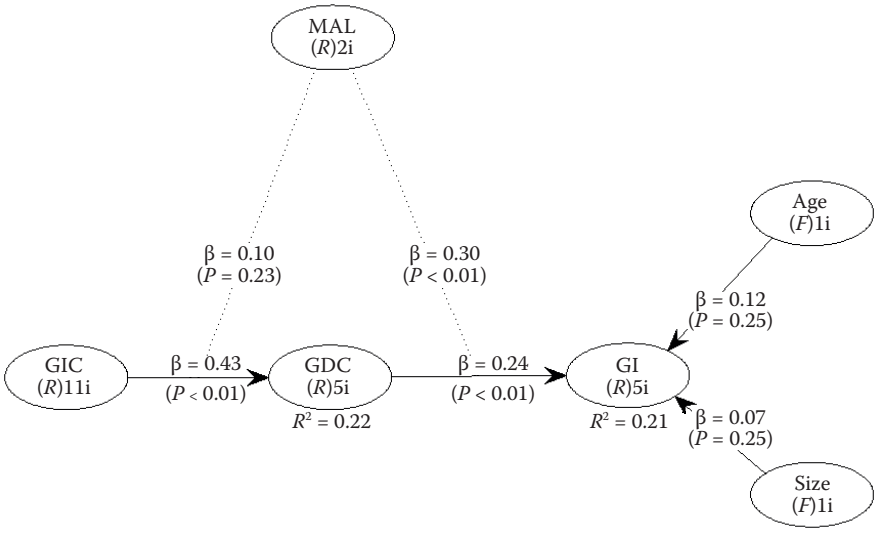

Figure 2. Partial least squares structural equation modelling (PLS-SEM) results

GIC – green intellectual capital; GDC – green dynamic capabilities; GI – green innovation; MAL – firms' motivation to achieve legitimacy

Source: Authors' own processing

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Table 3. Partial least squares structural equation modelling (PLS-SEM) results for hypotheses testing

Path	β	SE	*P*-value	Comments
Direct effects				
GIC → GDC	0.43**	0.062	< 0.01	–
GDC → GI	0.24**	0.080	< 0.01	–
Indirect effect				
GIC → GDC → GI	0.10**	0.041	< 0.01	H_1 supported
Moderator				
MAL × GIC → GDC	0.10	0.133	0.23	H_2 not supported
MAL × GDC → GI	0.30**	0.087	< 0.01	H_3 supported
Control variables				
Firm age → GI	–0.11	–	0.252	–
Firm size → GI	0.07	–	0.274	–

Model fit and quality indices

Average path coefficient (APC) = 0.191, $P < 0.001$
Average R-squared (ARS) = 0.227, $P < 0.001$
Average adjusted R-squared (AARS) = 0.208, $P < 0.001$
Average block VIF (AVIF) = 1.090, acceptable if ≤ 5, ideally ≤ 3.3
Average full collinearity VIF (AFVIF) = 1.603, acceptable if ≤ 5, ideally ≤ 3.3
Tenenhaus goodness-of-fit (GoF) = 0.441, small ≥ 0.1, medium ≥ 0.25, large ≥ 0.36
Simpson's paradox ratio (SPR) = 1.000, acceptable if ≥ 0.7, ideally = 1
R-squared contribution ratio (RSCR) = 1.000, acceptable if ≥ 0.9, ideally = 1

**$P < 0.01$; GIC – green intellectual capital; GDC – green dynamic capabilities; GI – green innovation; MAL – firms' motivation to achieve legitimacy; SE – standard error; VIF – variance inflation factor
Source: Authors' own processing

(β = 0.24, SE = 0.080, $P < 0.01$). For hypothesis 1 (H_1), which states that green IC prompts green DCs which in turn promote green innovation, we calculated the indirect effect to see the magnitude and direction of mediation. Referring to Table 3, green DCs positively mediate the relationship between green IC and green innovation (β = 0.10, SE = 0.041, $P < 0.01$), the results are statistically significant, hence supporting hypothesis 1 (H_1).

For hypothesis 2 (H_2), data failed to provide support regarding the moderation effect of the firms' motivation to achieve legitimacy for the relationship between green IC and green DCs [β = 0.10, SE = 0.133, not significant (ns)]. Hypothesis 3 (H_3) states that the firms' motivation to achieve legitimacy moderates the relationship between green DCs and green innovation and the results support this hypothesis as the coefficient of interaction effect is positive and significant i.e. β = 0.30, SE = 0.087, $P < 0.01$). We used simple and 3D plots to explore the patterns of the interaction effect. Figures 3, 4 show that green DCs and green innovation linkage is strong for firms reporting high levels of motivation to achieve legitimacy. However, the relationship pattern is relatively persistent even in the presence of low motivation, which suggests that lower motivation does not weaken the relationship. Nevertheless, a high level acts as a catalyst for firms to capitalize on green DCs to achieve green innovation. In sum, the results provided empirical support for hypotheses 1 and 3 (H_1, H_3), and imply that green

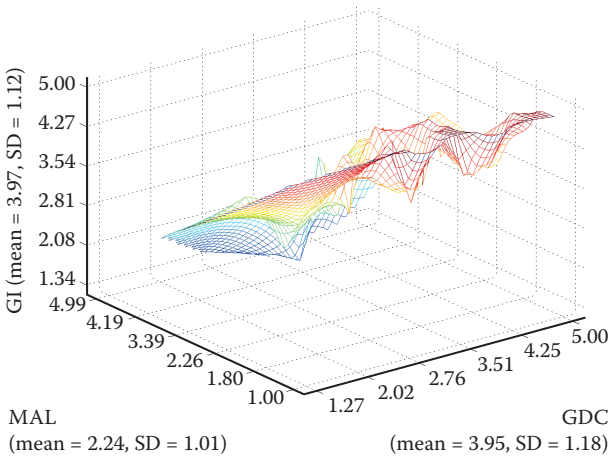

Figure 3. 3D graph to demonstrate moderation effect

GDC – green dynamic capabilities; GI – green innovation; MAL – firms' motivation to achieve legitimacy
Source: Authors' own processing

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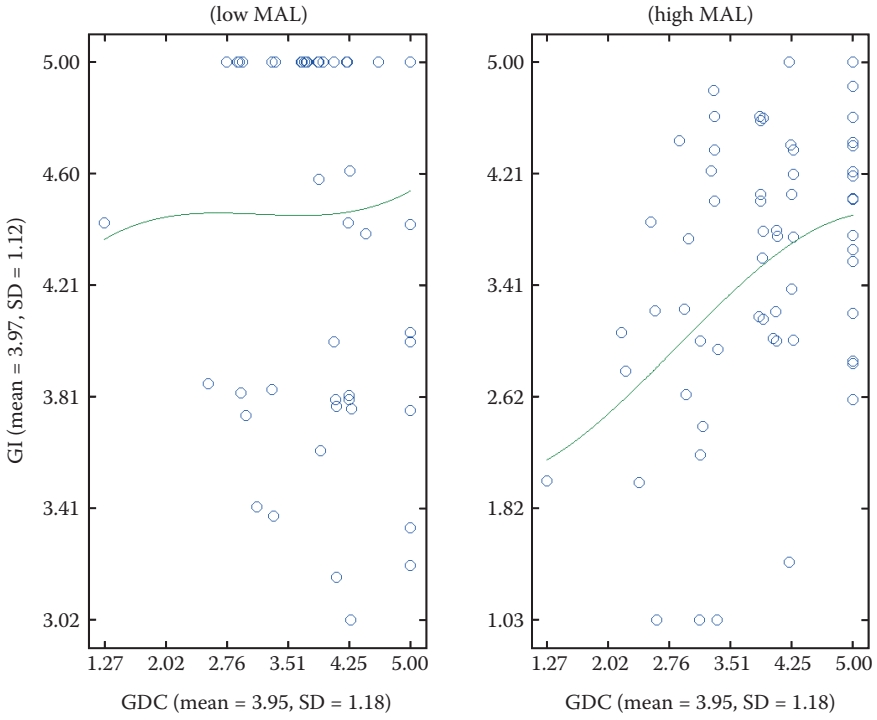

Figure 4. Simple graph with low and high values of moderator with data points

GDC – green dynamic capabilities; GI – green innovation; MAL – firms' motivation to achieve legitimacy

Source: Authors' own processing

IC and green DCs promote green innovation, as well as that green IC drives green DCs which in turn promote green innovation. Furthermore, the firms' motivation to achieve legitimacy increases the effectiveness of green DCs in predicting green innovation.

The present study offers a novel theoretical framework by integrating the resource-based view (RB-V), dynamic capability view (DC-V) and organisational theory, and extends our understanding of environmental management by the unique postulate of the mediating role of green DCs and the moderating role of motivation to achieve legitimacy in fostering green innovation. In particular, by using RB-V, this study posits green IC as an important resource for firms to develop core competencies and achieve goals, while DC-V is used to theorize green DCs as a key capability in responding to unstable and ever-changing business environments, and organisational theory to suggest a motivation for legitimacy as an institutional factor. The context-specific interaction between these elements encourages firms to adopt green innovations.

Our findings are important because the mediating effect has been largely overlooked until now, with the main focus on the direct effect of green IC on green innovation (Wang and Juo 2021). Our study reveals that green DCs mediate the relationship between green IC and green innovation and implies that green DCs are at the base of green innovation. These findings extend our understanding of how firms use their green resources to find green solutions in order to reduce pollutant emissions, environmental risk, and promote environmental sustainability. To do so, green DCs are postulated as an underlying mediating mechanism implying that intellectual resources make it easier for firms to develop DCs which in turn promote environmental management practices. These findings are consistent with earlier studies which also advocated that DCs are an important mechanism to prompt innovation (Singh et al. 2022). In short, findings imply that pooling employees' green values and beliefs, management's support and commitment to green culture, and the firms' relations with other partners based on principles of environmentalism enable firms to build green capabilities. Firms tap into green capabilities to respond to external pressure and changes regarding the need for green practices and products. In addition to that, our study also provides important insights into contextual factors in green innovation. In particular, it draws on organisational theory and suggests that the firms' desire to create a green image and build a green reputation motivates them to comply with environmental regulations and promote environmental management practices. In other words, the firms' motivation to achieve legitimacy stimulates green DCs to bring green innovation. Findings confirm that high motivation to achieve legitimacy strengthens the relationships between green DCs and green innovation. These findings are in line with the study of Tsinopoulos et al. (2018).

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Limitations and directions for future research. Despite its important theoretical and managerial implications, the present study is not free from limitations. First, it used a cross-sectional design and the data were collected from a single South Asian country. Future studies may opt for a longitudinal design and conduct a comparative examination of the result consistency across cultures. Moreover, future studies are recommended that use data triangulation to ensure scientific rigour and generalizability. Second, we used subjective self-report measures for green innovation. Future research may consider objective measures – e.g. a proxy using R&D expenditures, the number of new green products launched, and/or the return on green products, etc. – to extend the current understanding in terms of the influence of green IC and green DCs on green innovation. Third, this study used green DCs as a mediating mechanism. Researchers are encouraged to expand the theoretical base for underlying mediating mechanisms by offering other individual- and/or firm-level variables. Finally, future studies may investigate the role of regulatory institutions as catalysts for environmentalism beyond the firms' own motivation to attain legitimacy.

CONCLUSION

Nowadays, environmental management practices have become more than a buzzword for agricultural firms as the concerns of the international community, governments and firms regarding climate change, pollution and environmental degradation are constantly increasing. It is not only products but also manufacturing technologies that are harming the environment and, in some cases, the 3Rs of sustainability (i.e. Reduce, Remanufacture, Recycle) are loosely considered. The significant contribution of agricultural firms to socio-economic development (e.g. food supply, employment, etc.) and to environmental degradation (e.g. agricultural waste, excessive use of pesticides, waste from food and dairy products processing, burning remains of crops, etc.) calls for sustainability-driven business operations because these have a greater impact on the quality of life and ecosystems. In this regard, our study offers a unique theoretical framework to understand how and when agricultural firms may adopt green innovation to protect the ecosystem.

Our study suggests that the agricultural firms' green IC makes it easier for them to develop processes that are proficient in limiting pollution and designing products that follow principles of environmentalism. Findings confirm that the agricultural firms' green IC promotes green DCs which in turn drive green innovation. Finally, the findings confirm the moderating role of the firms' motivation to achieve legitimacy and imply that high motivation increases the effectiveness of green DCs in adopting green innovation. These findings recommend that managers inclined to embed pro-environment practices, processes and products may tap into green IC as well as green DCs.

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