The model of key green competencies influencing the phase of sustainable organizations

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Abstract

Purpose – *Drawing on the resource-based view (RBV) and dynamic capabilities theory (DCT), this study explores how key green competencies influence the transition between developmental phases of sustainable organizations. This study aims to determine which competencies most effectively drive organizations from lower to higher sustainability phases.*

Design/methodology/approach – *A survey was conducted among 100 manufacturing companies from Greater Poland, collecting data from 2017 and 2022 (200 organizational profiles). Dependency analysis and ordinal regression modeling were applied to identify significant relationships between specific green competencies and the developmental phases of sustainable organizations.*

Findings – *The study identified seven green competencies that positively affect advancement to higher sustainability phases: systems thinking, ecological integrity, project planning, SWOT analysis, value chain understanding, 4Ps of marketing and knowledge related to recycling centers and renewable energy. Conversely, niche exploration and facilitation/change management skills showed a negative association with advancement, possibly indicating stricter self-evaluation among more aware companies.*

Research limitations/implications – *The research is limited to manufacturing companies in Greater Poland and may not be generalizable to other sectors or regions. Future studies should explore the implementation of identified competencies across various contexts. The findings can guide training design and managerial strategies for enhancing sustainability.*

Practical implications – *The study offers a framework for managers aiming to enhance sustainability through human capital development. Identifying green competencies that drive progress between sustainability phases supports targeted training, recruitment and evaluation strategies. The results can guide organizations in building competency-based development paths and help policymakers design educational programs that foster green skills, improving environmental performance, resource efficiency and competitiveness.*

Social implications – *The findings show how green competencies foster responsible behavior, ethical decision-making and stakeholder engagement. Strengthening these skills enhances environmental outcomes, social equity and employee empowerment. By accelerating organizations' sustainability phases, the study supports building workplace cultures rooted in social responsibility, reducing the negative impacts of production and promoting inclusive and ethical business practices aligned with the Sustainable Development Goals (SDGs).*

Originality/value – *To the best of the authors, this paper presents one of the first empirical models linking green competencies with the developmental phases of sustainable organizations, offering practical insights for advancing organizational sustainability.*

Keywords *Sustainable organizations, Sustainable development, Green competencies, Green skills, Sustainable skills, Sustainable competencies*

Paper type *Research paper*

1. Introduction

The ongoing climate changes enforce rapid adjustments in process and functional aspects of enterprises. They must adapt their actions to address environmental concerns and foster sustainable development to become green and then progressively sustainable organizations. A green organization typically focuses on environmentally friendly practices, such as green innovation and green supply chain management practices, while a sustainable organization goes beyond just environmental concerns and also considers social and economic aspects, aiming for business sustainability through green intellectual capital and quality improvement practices (Fok *et al.*, 2022; Suki *et al.*, 2023). Additionally, green human resource management practices and green intellectual capital are crucial for business sustainability, aligning business strategies with environmental concerns (Montesano *et al.*, 2023). In essence, while green organizations prioritize eco-friendly initiatives, sustainable organizations encompass a broader spectrum because sustainability itself is a more complex concept to define and is very ambiguous (Molderez and Ceulemans, 2018). However, it is best understood from a company's perspective as a creation of long-term value, viability and competitive advantage by focusing on the Triple Bottom Line – social, environmental and economic realms (Amirmokhtar Radi and Shokouhyar, 2021). This approach is increasingly crucial because of societal pressure from many sources on businesses to become sustainable (Piwowar-Sulej, 2022).

Quite often, sustainability and sustainable development are used interchangeably, as expressed in the Brundtland Report (Brundtland, 1987), despite the difference between them. Sustainable development refers to the set of processes that stimulate development, or achieve progress, in a sustainable way. European Union initiatives, including the European Green Deal and the European Skills Agenda, emphasize the importance of sustainability, sustainable organizations and green competencies.

According to the resource-based view (RBV; Barney, 1991), organizations achieve sustainable competitive advantage by developing unique resources and capabilities that are valuable, rare, inimitable and non-substitutable (VRIN). Ecological competencies represent such strategic resources, as they integrate knowledge, skills and attitudes that align organizational outcomes with the Sustainable Development Goals (SDGs). The dynamic capabilities theory (DCT; Teece, 2025; Teece, 2005) emphasizes that organizations must continuously sense opportunities and threats, seize them and transform their resource base to maintain long-term advantage. Ecological competencies thus function as dynamic capabilities that facilitate learning, innovation and systemic adaptation toward higher stages of sustainable development.

The research included in this paper is a continuation of studies conducted in 2022–2023 (Graczyk-Kucharska, 2022a, 2022b, 2023). The results of these analyses made it possible to identify three phases of development and ten key green factors that help in measuring the development of sustainable organizations. Sustainable organizations can be defined by their development phase and the change between the phases can be accelerated by improving key green competencies inside the enterprise. Distinguished competencies are listed in the results chapter. This paper firstly investigates in the literature review section previous works in the field of sustainable competencies and related issues, then it clarifies the methodology used for statistical computations - dependencies analysis and ordinal regression model, followed by the corresponding results.

The aim of this research is to create a model of the impact of green competencies on the phase change of sustainable organizations; therefore, the formulated research question is as follows:

RQ1. How do key green competencies affect the transitions between developmental phases of sustainable organizations?

To address this question, an analysis was conducted using dependency analysis and ordinal regression modeling. This facilitated the identification of the most significant competencies within each phase and the determination of which of them increase the likelihood of advancing the development phase. By integrating qualitative insights with quantitative analysis, this paper offers a comprehensive understanding of how green competencies shape the direction of sustainable organizations.

2. Literature review

The following theoretical underpinnings are intended to review the research conducted to that point in two key areas for the article. Section 1 concerns topics connected to green competencies and the second part focuses on the phases of development of sustainable organizations.

2.1 Green competencies

Creating value and competitive advantage for an organization is achieved through organizational competencies, which are a collection of functional skills, knowledge and resources in research and development, production, logistics and marketing field (de Oliveira *et al.*, 2018). As awareness of environmental issues and sustainable development at the enterprise level arises, these advanced skills of individuals begin to be needed (Wiek *et al.*, 2011). Understanding what sustainability means will be necessary to equip graduates with the knowledge and abilities to significantly contribute to the realization of a sustainable future (Zeegers and Francis Clark, 2014).

According to the RBV perspective, organizations outperform their competitors by developing internal resources that are VRIN (Barney, 1991; Peteraf, 1993). Ecological competencies enhance ecological efficiency (valuable), yet relatively few organizations have fully integrated them into their core operational processes (rare). Moreover, they possess a tacit nature (inimitable), and technological or financial capital cannot easily substitute for the ecological knowledge embedded in human and organizational systems (non-substitutable).

Siva *et al.* (2018) defined sustainable competencies as skills and knowledge related to sustainability, which involve integrating considerations of the SDGs into product development and management practices. These skills not only improve the capacity to manage sustainable growth but also facilitate changes based on comprehensive human development for a sense of holistic well-being (Montanari *et al.*, 2023). Given their primary focus on environmental issues, green skills can be characterized as technical-scientific competencies associated with the creation of green jobs but also considering their influence on other aspects of a fair and inclusive transition (Montanari *et al.*, 2023; Vona *et al.*, 2015). These green competencies serve as incentives for individuals to consistently partake in activities that conserve resources and protect the environment.

According to Subramanian *et al.* (2016), the cultivation of such self-motivating competencies will collectively fulfill the requirement set by the World Commission on Environment and Development (WCED), also known as previously mentioned Brundtland Report, for "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Sustainable competencies are a broader concept, because they focus on implementing knowledge into organization, science and education to achieve SDGs, which for example aim to decrease poverty, diminish inequality and injustice and to cease climate change (Redman and Wiek, 2021).

In comparison, green competencies have potential to lessen environmental degradation of natural habits and enhance physical and mental health, as it dropped because of prompt

industrial growth (Cabral and Dhar, 2021). Graczyk-Kucharska (2022b) implemented that performance-related managerial competencies are the most important components of green competencies for the companies. It was also pointed out that the categories of activities that are the components of sustainable organizations are important and that the degree to which they are met has been increasing over time in recent years. Further studies presented by Graczyk-Kucharska (2022a) pointed out the division of competencies (knowledge, skills and attitudes) into three stages of the organization's development, indicating the key competencies for each stage of the development of sustainability management. Previously, Pham and Kim (2019) indicated that leadership strengthens the link between environmental practices and sustainability, but its understanding in relation to sustainability is still limited.

The green competencies analysed in this study are not mutually exclusive, and they partially overlap and complement one another. Their analytical distinction is intended to capture the different functional roles they play in the transformation of organizations toward sustainability. In organizational practice, these competencies often co-occur, forming an integrated set of capabilities supporting sustainable development.

2.2 Development phases of the sustainable organizations

An organization is a structure and disposition of resources, processes and individuals in their separate environment, with the purpose of achieving a specific objective. A special case of organizations is manufacturing organizations. Manufacturing companies are significant consumers of resources and sources of emissions – globally they account for about 24% of final energy consumption, 20% of water consumption and 21% of CO_2 emissions, and in Poland, these figures are even higher (IEA, 2022). Owing to their greatest environmental impact in the context of companies, these are the ones included in the empirical study. Product development and manufacturing organizations struggle in their sustainability transformation and do not sufficiently contribute to sustainable production and consumption (Mallalieu *et al.*, 2024).

Sustainable organizations are those in which management of production, organization and marketing is in accordance with the principles of sustainable development (Graczyk-Kucharska, 2022b). Based on social, natural and economic pillars, principles for functioning these types of organizations have been established for the use of environmentally friendly technologies, waste reduction, energy efficiency and sustainable resource management (Hart and Milstein, 2003). To align business models with sustainable development and circular economy principles, sustainable visioning is needed. This process leverages powerful corporate vision to drive transformative change across an organization and beyond, deeply committing to the concerns of people, planet and prosperity (Madsen and Ulhøi, 2021).

The delineation of developmental phases of sustainable organizations was described by Graczyk-Kucharska (2023). Performed analysis aimed to categorize companies into clusters based on shared traits while maximizing the differences between these groups. In the study, a variable named Phase was established and attributed to the respective clusters in accordance with the Hartigan–Wong algorithm, as outlined in the cluster analysis stage. The allocation was determined based on the progressive centroid values. According to a study, there are three development phases of green organizations, and there are hypotheses that the introduction of Green Marketing and Green Human Resource Management into an organization can become crucial for changing the development stage from lower Phase 1 to higher Phase 2. From the perspective of the DCT (Teece, 2007, 2025), such transitions between stages of sustainable development can be understood as manifestations of an organization's ability to sense, seize and transform its internal resources in response to changing environmental and market conditions.

Green Human Resources Management is a concept that combines practices related to human resources policies and management, and environmental aspects to contribute to the development of sustainability (Faisal, 2023). Categories of Green Supply Chain Management and Zero Waste Buildings can become catalysts for accelerating an organization's transition from Phase 2 to Phase 3. Worth noting is that it was also analyzed how the development phase of a given company changed between the situation in 2022 and 2017. It turns out that 83 companies did not change phase, 15 noted an increase in the level of proenvironmental competence, and in 2 companies, a change in phase to a less advanced one was noticed. In the context of investigating key green competencies and their impact on the transition of sustainable organizations through developmental phases, the results outlined above play a crucial role in shaping the current article's research methodology.

3. Research methods and data source

Results presented in this paper are a continuation of the previous research findings. The data was gathered from the responses provided by representatives of 100 businesses from the manufacturing industry in Greater Poland. Each of the representatives determined the level of green competence at two time points – 2017 and 2022. The 2017 and 2022 company profiles are treated as profiles of independent organizations, so the database was 200 observations.

Although the data were collected from the same firms at two time points (2017 and 2022), each observation was treated as an independent organizational profile, as the study does not aim to analyze intra-organizational change over time but to examine relationships between green competencies and sustainability phases. Over the five-year period, firms operated under substantially different regulatory and strategic conditions, which may have altered their organizational structures and sustainability orientations. Consequently, the adopted analytical approach is considered appropriate and well aligned with the objectives of this study.

The research tool was built on the basis of three sections. Section 1 covered basic organizational and respondent characteristics. Section 2 evaluated the current level of fulfillment (rated from 0 to 6) in various categories within the company, including Sustainable Production, Green Human Resource Management, Knowledge and Awareness of Ecology and Sustainability, Environmental Management, Resource Consumption Reduction, Green Marketing, Green Product Design, Green Supply Chains, Closed Circuit Waste Management and Zero Waste Buildings. Section 3 of the survey gathered data on the extent to which the company meets the 80 competencies listed according to the previously adopted methodology (Graczyk-Kucharska, 2022a, 2022b).

Figure 1 illustrates how previous research influenced the methodology and workflow of this paper. The workflow consists of three main steps:

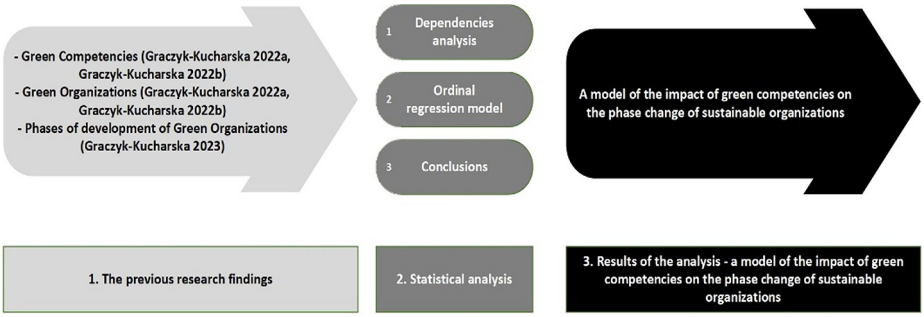
1. consideration of findings from prior research to guide the statistical analysis;
2. execution of the statistical analysis; and
3. presentation of the results, which form the model of key green competencies influencing the phase of sustainable organizations.

In this chapter only methodology used in this paper is described – dependencies analysis and ordinal regression model, as previous research findings are elaborated in literature review sections, and results and conclusions are delineated in the subsequent sections of this paper.

3.1 Dependencies analysis

Profiling was conducted by comparing the distribution of responses to questions from Section 3 of the survey to belonging in already established clusters and by calculating the

Figure 1 Research methodology



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statistical values based on the chi-square test or Fisher's exact test. For each question, a contingency table of dimensions $r \times c$ was created, where r is the number of rows (number of response variants), and c is the number of columns (number of phases). The observed counts O_{ij} indicate how many subjects assigned to phase j gave response i. Table 1 represents an exemplary layout of the output table. W_i represents the sum of values occurring in the row, while K_j denotes the sum obtained in the respective columns.

The chi-square test involves determining the theoretical counts assuming independence between variables. The significance of the difference between observed and theoretical values is then examined. If this difference is significant at the predetermined significance level (0.05 to alpha), it can be concluded that the variables are not independent. The χ^2 statistic is calculated using the formula (1), as described by Aczel (2000):

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{\left(o_{ij} - \widehat{o}_{ij}\right)^2}{\widehat{O}_{ij}} \quad (1)$$

where:

O_{ij} – observed abundance in the i-th row and j-th column, and

$\widehat{O}_{ij} = \frac{W_i K_j}{n}$ – theoretical abundance in the i-th row and j-th column.

It is recommended to perform the chi-square test when theoretical values are greater than 5. Otherwise, a more computationally complex Fisher's exact test for $r \times c$ tables would be attempted, which was not necessary in this article. The calculated p-values were determined based on Monte Carlo simulations.

Table 1 Sample contingency table

Response options	*Phase 1*	*Phase 2*	*Phase 3*	*Total*
I do not understand this term at all	O_{11}	O_{12}	O_{13}	W_1
I am not familiar with this concept	O_{21}	O_{22}	O_{23}	W_2
To a very small extent	O_{31}	O_{32}	O_{33}	W_3
To a small extent	O_{41}	O_{42}	O_{43}	W_4
On average	O_{51}	O_{52}	O_{53}	W_5
To a large extent	O_{61}	O_{62}	O_{63}	W_6
To a very large extent	O_{71}	O_{72}	O_{73}	W_7
	K_1	K_2	K_3	

Source(s): Authors' own work

3.2 Ordinal regression model

The final step of the analysis involved modeling using ordinal regression. This method is used for modeling variables presented on an ordinal scale, meaning they are ranked according to a specific, predefined hierarchy. The ordinal regression model predicts the category for each respondent and provides the probability of belonging to each possible category. The one with the highest probability is then selected. To determine these probabilities, a series of logistic regressions (2) is considered, as described by Gelman and Hill (2006):6

$$\begin{aligned} Pr\,Pr(y > 1) &= logit^{-1}(X\beta) Pr\,Pr(y > 2) = logit^{-1}(X\beta - c_2) Pr\,Pr(y > 3) \\ &= logit^{-1}(X\beta - c_3) \\ &\dots \\ \Pr(y > K - 1) &= logit^{-1}(X\beta - c_{K-1}), \end{aligned} \tag{2}$$

where:

y – explanatory variable (category);

X – matrix of explanatory variables;

β – vector of model parameters; and

c_i – cutpoint.

Hence, the probability of determining the value for a particular category can be determined using the Formula (3):

$$(y > k - 1) - Pr(y > k) = logit^{-1}(X\beta - c_{k-1}) - logit^{-1}(X\beta - c_k) \tag{3}$$

The logistic regression model was constructed using a forward stepwise regression based on minimizing the Akaike Information Criterion (AIC) for the "phase" variable. This method is used for selecting variables for different regression models, including logistic regression. Its aim is to choose a model that provides as much information as possible with a limited number of variables. The criterion is calculated using the Formula (4) described in Akaike (1973):

$$\text{AIC} = -2\sum_j ln(\widehat{\pi}_j) + 2q \tag{4}$$

In Formula (4) $\widehat{\pi}_j$ denotes the estimated probability, under the assumptions of a given model, of obtaining just such an observation value as was really obtained, while q is the number of model parameters. Initially, models with one explanatory variable, equal to the number of variables, are built. The variable for which the model achieved the smallest AIC is selected. Models with two variables are then built, with one being the variable selected in the previous step, and the other being a variable not yet included. Again, the model with the smallest AIC is chosen. This process continues until the assumed number of variables is reached or when the p-value for the next variable is greater than the assumed significance level.

Ten variables were selected using the "one in ten rule" meaning that for each explanatory variable in the model, there should be at least 10 observations. When choosing 10 variables in this study, there are 20 observations for each. Odds ratios (OR) were used to analyze the impact of explanatory variables on the phase. The odds ratio represents the ratio of the odds of an event occurring, described by the dependent variable, in a group of companies with a certain characteristic to the odds of its occurrence in the group of other companies.

The odds themselves represent the ratio of the probability of the occurrence of a given event to its nonoccurrence (Hosmer and Lemeshow, 2000). When the odds of an event occurring are 50%, and the odds of its nonoccurrence are also 50%, the odds ratio is 1. This means that the factor has neither a positive nor a negative impact on the phenomenon under investigation. If the odds ratio is greater than 1, it indicates that the chance of the event occurring is greater in the group with a certain characteristic.

The odds ratio can be interpreted as a measure of association. For an odds ratio of 1.45, it is interpreted that the chance of the event occurring increased by 1.45 times or 45% compared to the reference group. On the other hand, when the odds ratio is in the range (0,1), it means that the factor reduces the chance of the event occurring. To interpret how many times the chance decreases, the inverse of the odds ratio is calculated. For example, if OR = 1/4, the chance of the event occurring due to that factor decreased fourfold. When there are several levels of the explanatory variable, the odds ratio informs the reader how many times the chance of the phenomenon occurring increases/decreases with a one unit change in that explanatory variable, assuming *ceteris paribus*. The odds ratio is an estimator determined based on information from the sample. Its value obtained in a random sample may differ from that in the population. It is necessary to compare the obtained odds ratio with the confidence interval. In this analysis, a 95% confidence interval was used. It represents the range of values within which the true odds ratio occurring in the population is found with a 95% probability. The subject of investigation in the analysis is to examine which competencies have a significant impact on the change of the organization's development phase to a higher one.

4. Results

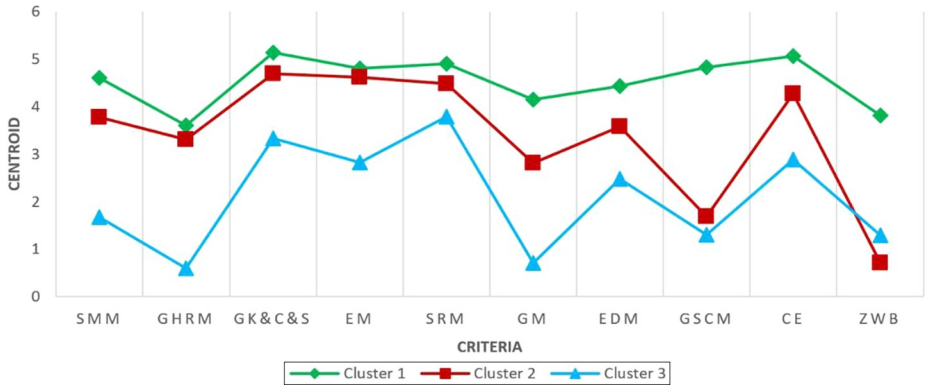
In previous research (Graczyk-Kucharska, 2022a) author has published the results of research relating to key factors in an organization that can influence organizational development. Key distinguished factors, that has given overall view of organization development included: Sustainable Manufacturing Management (SMM), Green Human Resources Management (GHRM), Green Knowledge, competencies, skills and attitudes (GK&C&S), Environmental Management (EM), Sustainable Resource Management (SRM), Green Marketing (GM), Eco-design Product Management (EDM), Green Supply Chain Management (GSCM), Circular Economy (CE) and Zero-waste buildings (ZWB).

These ten factors were selected by means of scientometric analysis of bibliography, collated with answers from 100 manufacturing companies (Graczyk-Kucharska, 2023), which allowed the final definition of the phases of sustainable organizations. The establishment of three distinct developmental phases within sustainable organizations was achieved through a systematic analysis of centroid values. These values were examined to determine the assignment of clusters in ascending order, resulting in the categorization of Phase 1, Phase 2 and Phase 3. Consequently, Cluster 3, characterized by the lowest values for each category, was designated as Phase 1, followed by Cluster 2 as Phase 2, and Cluster 1 as Phase 3. This approach ensured a clear delineation of developmental stages based on the progression of centroid values, thereby facilitating the identification of distinct phases in the organizational development trajectory.

In further analysis, a division into 3 clusters was considered (see Figure 2 and Table 2). The average values obtained for each parameter are shown below.

Based on these phases of development, it was decided to see which competencies contribute most significantly to the phase change of sustainable organizations. To this end, in the first stage, a total of 138 components were defined in four areas: knowledge, skills, attitudes and accelerated managerial skills, based on literature research (Graczyk-Kucharska, 2022a, 2022b). On the basis of early research results, 80 of them were identified

Figure 2 Centroids scatter plot for three cluster



Source: Graczyk-Kucharska (2023)

Table 2 Average values of factors in clusters

No.	*Factors of sustainable organizations*	*Cluster* *1*	*2*	*3*
1.1	ZWB	3.81	0.71	1.29
1.2	EDM	4.43	3.58	2.47
1.3	CE	5.06	4.27	2.89
1.4	SRM	4.90	4.48	3.79
1.5	GK&C&S	5.14	4.69	3.33
1.6	EM	4.80	4.62	2.82
1.7	GSCM	4.83	1.69	1.30
1.8	GHRM	3.60	3.31	0.60
1.9	GM	4.15	2.81	0.71
1.10	SMM	4.61	3.77	1.67

Source(s): Authors' own work

as key ones, which were further included in the quantitative research and their impact on the sustainable development of the 100 organizations studied.

4.1 Dependencies analysis results

Contingency tables were constructed for each of the questions in Section 3 of the survey. Appendix shows the number of responses to each question by phase. Only for two competencies was the relationship not significant at the $\alpha = 0.05$ level. These variables were: *Human Rights* and *Social Justice*. For these variables, it was not statistically proven that the phase affects the variation in their level.

Among the Phase 1, more than 50% of companies rated the following competencies at a very high level: *Human Rights*, *Administration, Environmental Management Systems*, *Behavior toward the manufacture of green products. Labeling products as environmentally safe, recycling and collecting packaging and developing products that cause the least damage to the environment.*

Phase 2 companies are less likely to give a very high rating. 46% of Phase 2 companies and 36% of Phase 3 companies give a very high rating to *Human Rights*. As this competency was rated the highest in each of the phases, it is not important in the phase evaluation.

It was checked which of the relevant competencies are rated highest in the companies in Phase 2 50% of them rated as fulfilling the competency *Awareness of sustainable development, especially environmental, social and economic to a high degree*. In addition, they also stand out with a high rating for competency *The ability to analyze data, evaluate results and recommend actions* and *Leadership* (48% of Phase 2 respondents gave a fulfillment rating of "to a great extent").

Phase 3 companies represent the lowest percentages with the response options "to a great extent" and "to a very great extent." The highest values were observed for competencies: *Project management and prioritization* and *Ability to analyze data, evaluate results and recommend actions*.

4.2 Ordinal regression model results

An ordinal logistic regression model was created, in which the explanatory variable (y) is phase membership taking the values: "Phase 1", "Phase 2" or "Phase 3" and the explanatory variables (x_1, x_2, …, x_3) are the organization's environmental competencies defined on a scale from 0 to 6. The model was created on the basis of stepwise regression. The variables that had the greatest impact on the model, because of the Akaike criterion, were added until the assumed 10 variables in the model were obtained.

In Table 3, logistic regression coefficients are presented, and their significance is assessed. The test statistic value is provided, along with the calculated probability (referred to as the p-value). The obtained p-values confirm that all variables in the model are statistically significant at the assumed significance level of $\alpha = 0.05$, as $p < 0.05$. Additionally, odds ratios are presented, along with the 95% confidence intervals for the true odds ratio in the population. The odds ratio allows inference about the strength of the relationship between individual variables and occurrence in a specific phase.

The variable related to skill *Systems Thinking* achieved the highest coefficient in the regression analysis, with a value of 0.507. This positive coefficient indicates a favorable impact on the increase in the developmental phase. The odds ratio is 1.661, signifying that a one unit increase in systems thinking is associated with a 66% higher likelihood of advancing to the next organizational development phase.

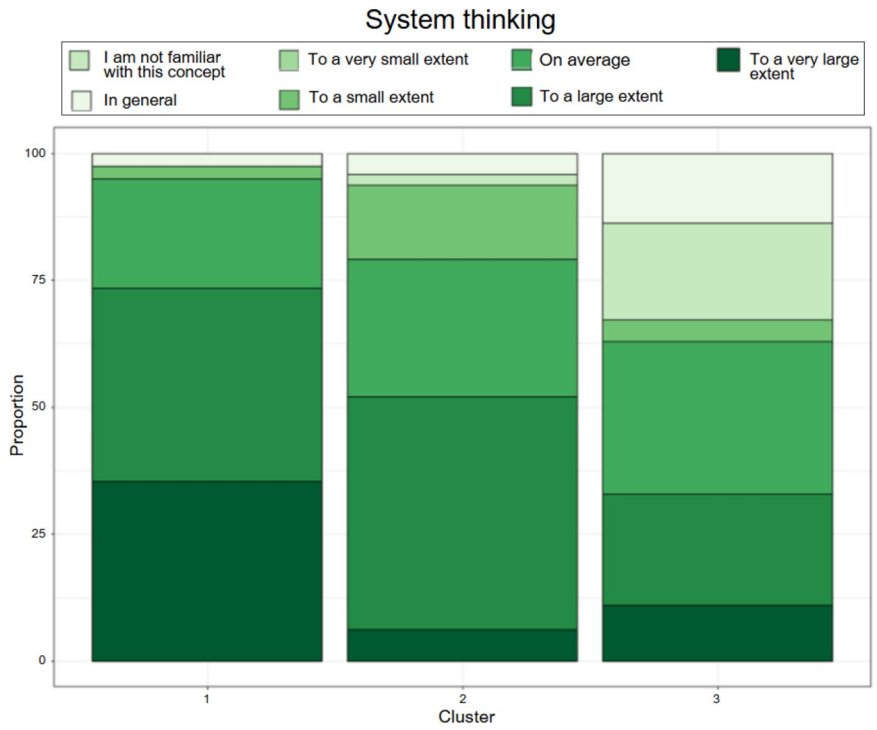
Figure 3 illustrates that the majority of respondents in Cluster 1 rated their proficiency in systemic thinking as high or very high. Few individuals were unfamiliar with this concept. In

Table 3 Order regression model for the variable phase

Variable	*Coeffi-cient*	*Stand-ard error*	*Z value*	p = *Pr(>|z|)*	*Odds ratio*	*2.5%*	*97.5%*
Ecological integrity	0.418	0.134	3.12	0.002	1.518	1.168	1.974
SWOT analysis	0.315	0.083	3.80	0.000	1.370	1.164	1.611
Project planning	0.396	0.126	3.15	0.002	1.486	1.161	1.901
Niche exploration	−0.626	0.136	−4.59	0.000	0.535	0.409	0.698
Value chain	0.212	0.089	2.39	0.017	1.236	1.039	1.470
Knowledge related to recycling centers, renewable energy sources, utilized spaces and access to sustainable services	0.414	0.153	2.71	0.007	1.513	1.122	2.040
System thinking	0.507	0.163	3.11	0.002	1.661	1.206	2.286
4 Ps of marketing	0.179	0.083	2.17	0.030	1.196	1.017	1.407
Facilitation skills, change management and group process management	−0.229	0.094	−2.43	0.015	0.796	0.661	0.957
Natural capital	0.187	0.094	2.00	0.046	1.206	1.004	1.448

Source(s): Authors' own work

Figure 3 Relationship between variable 3.09, systems thinking and cluster affiliation



Source: Authors' own work

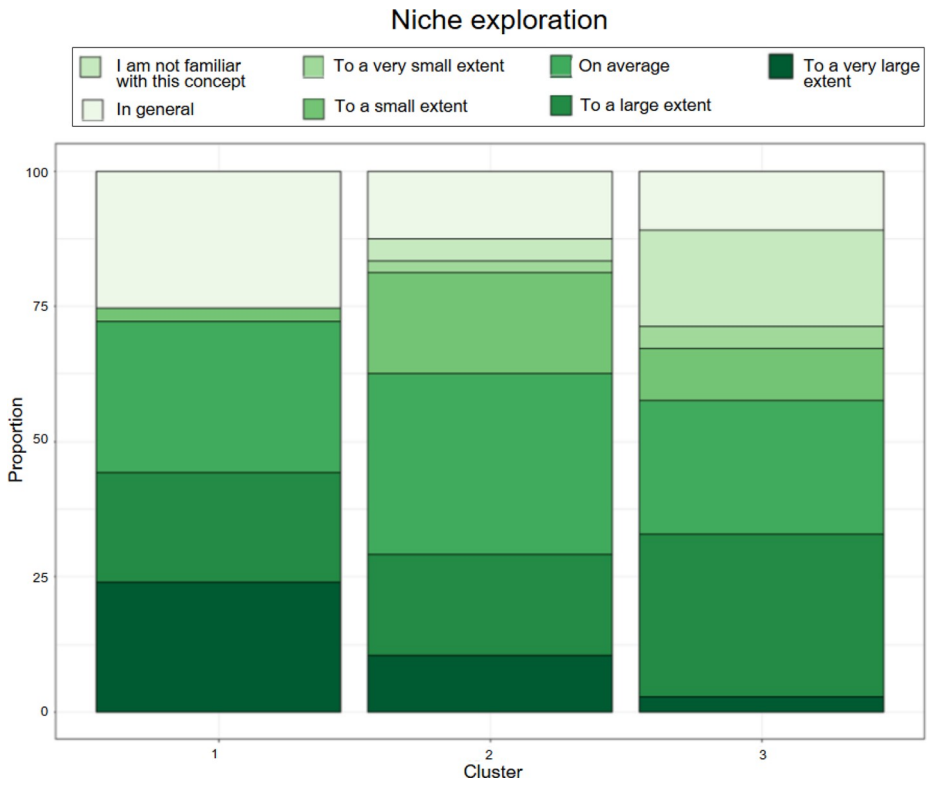
the second phase, there was an increase in the percentage of individuals assigning a very weak rating, and a decrease in the percentage of organizations with very high proficiency in this skill. In Phase 3, a notable proportion of individuals exhibited a lack of understanding and demonstrated no skills in systems thinking.

The next variables, which also exert a strongly positive influence on the advancement of the developmental phase, are knowledge in the area of *Ecological Integrity* (a 1.5-fold increase in this competency increases the likelihood of advancing to the next phase), *Knowledge related to recycling centers, renewable energy sources*, *utilized spaces and access to sustainable services,* for which the odds ratio is also approximately 1.5, and *Value chain* – with the odds ratio equaled 1.236. Skills *SWOT Analysis, 4Ps of Marketing* and *Project Planning* also positively impact the transition to a higher phase.

For the variable related to knowledge – *Niche Exploration*, a negative regression coefficient was obtained. Moreover, the odds ratio obtained is below 1. This signifies that an increase in knowledge about niche exploration has a negative impact on the advancement of the developmental phase. Elevating the proficiency level in this competency by 1-unit results in a twofold decrease in the likelihood of transitioning to a higher phase.

Based on the observation of Figure 4, which depicts the percentage of responses provided by organizations in different phases, it can be noted that 25% of respondents in Phase 1 do not understand the concept of *Niche Exploration*. However, at the same time, this Phase exhibits the highest percentage of individuals who fulfill this competency to a large or very large extent. The 95% confidence interval for the odds ratio of this variable does not include the value 1, indicating the possibility of no relationship in the entire population. Therefore, the negative correlation is not random at a 5% significance level.

Figure 4 Relationship between variable 2.16, niche exploration and cluster affiliation



Source: Authors' own work

The negative regression coefficient may be influenced by unfamiliarity with the concept rather than its negative impact on organizational development. This is an atypical situation where, within companies of a single phase, there is simultaneously the highest percentage of individuals fulfilling the skill to a very high extent and the highest percentage of individuals not understanding the concept compared to the other two groups. This could also suggest that higher awareness among companies translates into more stringent evaluations.

The variables from the managerial competence group, *Facilitation Skills, Change Management and Group Process Management*, also obtained negative regression coefficients. An increase in this competency reduces the likelihood of transitioning to a higher developmental phase by 25%. In the confidence interval for the odds ratio, value 1 is not present, but the right end of the interval is close to this value. This suggests that in the population, this variable may not have a significant impact on the phase transition. Similarly, for variable *Natural Capital*, which is at the borderline of the acceptable level of significance.

In the logistic regression model, variables strongly correlated with the significant variables already present in the model do not appear. This is because of the Akaike criterion, which involves selecting variables that most improve the informativeness of the model. It is essential to examine variables with similar variability to significant variables in the model that did not appear. Below (Table 4) are competencies paired with variables from Table 1, showing the highest Pearson correlation coefficients.

Moderate correlation coefficients (approximately 0.6) indicate that as one competency increases, the level of the other also increases. This may stem from the similarity between both competencies and their concurrent development; for example, project planning skills

Table 4 Pairs with the highest Pearson correlation coefficient with variables significant in the model

Significant variable	*Variable most strongly correlated with the significant variable*	*Pearson correlation coefficient*
Ecological integrity	Environmental problem analysis	0.59
SWOT analysis	Assisting departments in developing indicators specific to their areas of work	0.43
Project planning	Sustainable development planning	0.56
Niche searching	Gross domestic product	0.48
Value chain	Gross national product	0.45
Knowledge related to recycling centers, renewable energy sources, utilized spaces and access to sustainable services	Knowledge on reducing energy and resource consumption, reducing greenhouse gas emissions, reducing waste and pollution and conserving and protecting nature	0.59
System thinking	Economic justification	0.62
4 Ps of marketing	Understanding the significance, process of defining and utility of sustainable development indicators	0.32
Facilitation skills, change management and group process management	Identifying sources of funding for society and sustainable development projects	0.57
Natural capital	Globalization	0.47

Source(s): Authors' own work

may often be developed alongside sustainable development planning skills. Similarly, an increase in knowledge related to recycling centers, renewable energy sources, utilized spaces and access to sustainable services often coexists with an increase in knowledge about energy and resource consumption reduction, greenhouse gas reduction, waste and pollution reduction, as well as nature conservation and protection.

The results indicate that although some competencies exhibit moderate interdependencies, this does not imply redundancy. Instead, these competencies perform complementary functions by strengthening different aspects of organizational transitions between sustainability phases. Their partial overlap reflects the complex and systemic nature of green competencies within organizations.

5. Discussion

The research findings effectively address the formulated research question by revealing how specific green competencies influence the transitions between developmental phases of sustainable organizations, elucidating key factors that drive organizational advancement towards greener practices. Regarding the influence on phase shift, sustainable organizations should pay particular attention to the level of system thinking in their areas of operation. This flexible competence is applicable at strategic, tactical and operational levels. Sengupta and El-Halwagi (2017) claim that system thinking is considered a competency in sustainable organizations as it disaggregates complex problems, studies interrelations and synthesizes various elements into a complete and integrated system.

While systems thinking includes the functional aspect of the green organization's activities, ecological integrity finds its deployment in the process dimension. This competency enables the consideration of an organization's impact in the context of biological diversity and environmental processes. According to Gull and Idrees (2022), ecological integrity refers to the ability of employees to adopt eco-efficient practices through green training, enhancing organizational efficiency and environmental protection.

Similar in significance, considering the impact on phase shift has knowledge related to recycling centers, renewable energy sources, utilized spaces and access to sustainable services. The applicability of this knowledge spans various organizational levels, influencing both strategic decisions and day-to-day operations. This competence represents the broader criterion - the green knowledge, which refers to utilizing knowledge on eco-friendly

practices like recycling, renewable energy, sustainable services and efficient space usage to drive green innovation and performance (Abbas and Khan, 2023).

Following the recommendation based on the results, green organizations must conscientiously employ SWOT analysis to strategically evaluate internal strengths and weaknesses along with external opportunities and threats. In green organizations it aids in strategic planning for sustainable development (Chen, 2022) allowing for enhancing sustainability and profitability in the long term (Taherdoost and Madanchian, 2021).

Another element used in marketing analytics, which, when considered as a competence, has a positive impact on the phase transition, is the 4Ps of marketing. This foundational marketing strategy, composed of Product, Price, Place and Promotion, can adopt a sustainability focus. The competence involves weaving environmental considerations into product design, pricing strategies, distribution and promotional activities. It also positively impacts corporate brand images and consumers' purchase intentions, promoting green behaviors (Tian and Lee, 2020).

Project management is a development tool for greening enterprises by analyzing issues, determining objectives, justifying the project, developing appropriate documentation and identifying funding sources and structures (Shmatko *et al.*, 2021). Crucial part of project management is project planning, which ensures that the project is completed within organizational, time and budget constraints (Rose and Indelicato, 2009). This competency has a positive impact on the phase shift. It ensures the successful execution of green initiatives, minimizing resource consumption and contributing substantially to the organization's sustainability goals.

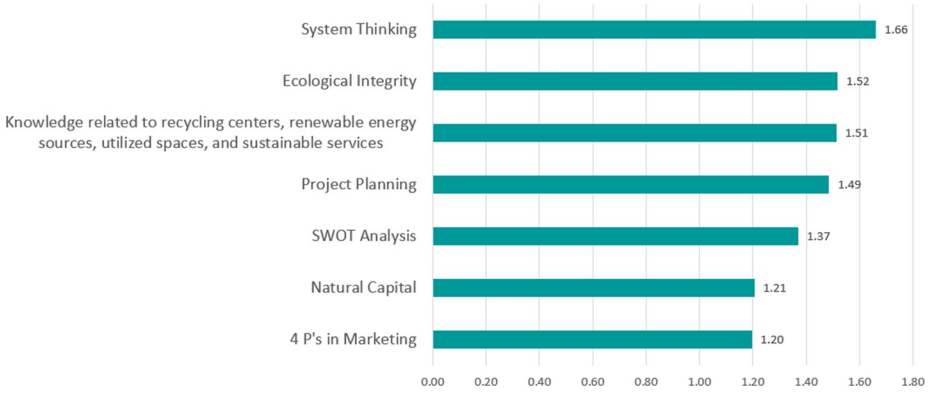
Within the context of phase transition, a green organization's commitment to sustainability is exemplified also through the understanding and optimization of the value chain. Understanding the value chain as a competency in green companies helps create competitive advantages (Schenkel *et al.*, 2015). It helps drive green innovation in sustainable supply chains, with fairness perceptions, embeddedness and knowledge sharing playing key roles (Zhou *et al.*, 2020). This competence involves assessing and improving each stage, from sourcing to delivery, with a focus on minimizing environmental impact and ensuring ethical sourcing.

Integrated management of these competencies can accelerate organizational progression between sustainability phases, particularly when their interactions and reinforcing effects are strategically considered. When prioritizing, it is essential not to overlook the impact strength of each mentioned competence. For a clearer representation of this hierarchy, the odds ratio is presented in Figure 5.

6. Conclusions

From a theoretical perspective, this study extends the RBV and DCT frameworks to sustainable development, showing that ecological competencies act both as strategic resources and as dynamic capabilities driving organizational transformation toward higher sustainability maturity. The identified set of seven ecological competencies demonstrates VRIN characteristics and enables organizations to sense environmental opportunities, seize innovation and transform operations. The aim of the presented research was to identify competencies that significantly influence transitions between developmental phases of sustainable organizations. The empirical results revealed seven competencies whose possession positively impacts the development of a sustainable organization: 4P's in marketing, natural capital, SWOT analysis, project planning, knowledge related to recycling centers, renewable energy sources, utilized spaces and access to sustainable services, ecological integrity and system thinking. Importantly, competencies such as niche exploration, facilitation and change management exhibited negative correlations with development transitions, suggesting potential inhibitory mechanisms or higher levels of self-assessment

Figure 5 Odds ratio



Source: Authors' own work

among mature organizations. These findings highlight directions for future research into the barriers and self-limiting dynamics of organizational sustainability transformation.

This paper presents one of the first empirical models that links green competencies with the developmental phases of sustainable organizations. A limitation of the study is that the research sample consisted only of manufacturing companies, narrowing the scope of inferences. Moreover, these companies are located in the European Union and are not significantly geographically dispersed, as all firms were based in the Greater Poland region, which might have affected the outcomes due to the variety of programs adopted by the EU mentioned in the Introduction. Furthermore, the identification of competencies provides essential theoretical knowledge that may suggest practical applications. However, comprehensive exploration of implementation techniques and the development of these competencies is necessary for their full utilization. The development of sustainable organizations is a continuous and dynamic process, and knowledge about green competencies is crucial, as it can influence the pace of this development and enable faster and easier achievement of intended sustainability goals.

From a managerial perspective, the findings suggest that ecological competencies should be integrated into human resource development, training systems and leadership programs to enhance an organization's ability to transition between the phases of sustainable development. In practice, these implications can be implemented across organizational levels, with top management using ecological competencies strategically, middle management coordinating their application across functions, departments integrating the SDGs into daily operations and employees fostering pro-environmental behaviors in the workplace.

The study also points to a new research direction by identifying competencies that appear to inhibit development in organizations at more advanced stages of sustainability maturity, such as niche exploration, facilitation and change management skills. This negative association may reflect a higher level of critical awareness and self-assessment among more advanced organizations. Future research should further investigate such inhibiting or self-limiting dynamics to better understand their impact on organizational transformation toward sustainability.

Author contribution

Magdalena Graczyk-Kucharska, Writing – Review and editing, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data

curation, Conceptualization. Mikołaj Andrzej Adamczak, Writing – Review and editing, original draft. Katarzyna Maria Łucka, Writing – Review and editing, Original draft. Karolina Kurzyńska, Writing – Review and editing, Original draft.

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Appendix

Table A1 Responses from companies and their assignment to clusters of sustainable organization development phases. $n = 200$, as each result was treated as separate for each of the companies surveyed in 2017 and 2022

Competencies	*Scale*	*Cluster 1* (n = *79*)	*Cluster 2* (n = *48*)	*Cluster 3* (n = *73*)	*test*	p-*value*
Ecological integrity	I am not familiar with this concept	5.1% ($n = 4$)	4.2% ($n = 2$)	24.7% ($n = 18$)	Chi-square	*<0.001*
	Not at all	0% ($n = 0$)	2.1% ($n = 1$)	9.6% ($n = 7$)		
	To a very small extent	0% ($n = 0$)	4.2% ($n = 2$)	12.3% ($n = 9$)		
	To a small extent	3.8% ($n = 3$)	8.3% ($n = 4$)	15.1% ($n = 11$)		
	To an average extent	22.8% ($n = 18$)	31.2% ($n = 15$)	19.2% ($n = 14$)		
	To a large extent	41.8% ($n = 33$)	39.6% ($n = 19$)	16.4% ($n = 12$)		
	To a very large extent	26.6% ($n = 21$)	10.4% ($n = 5$)	2.7% ($n = 2$)		
SWOT analysis	I am not familiar with this concept	15.2% ($n = 12$)	35.4% ($n = 17$)	37% ($n = 27$)	Chi-square	*<0.001*
	Not at all	5.1% ($n = 4$)	6.2% ($n = 3$)	17.8% ($n = 13$)		
	To a very small extent	0% ($n = 0$)	0% ($n = 0$)	6.8% ($n = 5$)		
	To a small extent	6.3% ($n = 5$)	2.1% ($n = 1$)	9.6% ($n = 7$)		
	To an average extent	16.5% ($n = 13$)	22.9% ($n = 11$)	21.9% ($n = 16$)		
	To a large extent	30.4% ($n = 24$)	25% ($n = 12$)	6.8% ($n = 5$)		
	To a very large extent	26.6% ($n = 21$)	8.3% ($n = 4$)	0% ($n = 0$)		
Project planning	I am not familiar with this concept	6.3% ($n = 5$)	4.2% ($n = 2$)	12.3% ($n = 9$)	Chi-square	*<0.001*
	Not at all	0% ($n = 0$)	14.6% ($n = 7$)	23.3% ($n = 17$)		
	To a very small extent	0% ($n = 0$)	0% ($n = 0$)	4.1% ($n = 3$)		
	To a small extent	1.3% ($n = 1$)	10.4% ($n = 5$)	11% ($n = 8$)		
	To an average extent	20.3% ($n = 16$)	33.3% ($n = 16$)	30.1% ($n = 22$)		
	To a large extent	38% ($n = 30$)	29.2% ($n = 14$)	19.2% ($n = 14$)		
	To a very large extent	34.2% ($n = 27$)	8.3% ($n = 4$)	0% ($n = 0$)		
Niche searching	I am not familiar with this concept	25.3% ($n = 20$)	12.5% ($n = 6$)	11% ($n = 8$)	Chi-square	*<0.001*
	Not at all	0% ($n = 0$)	4.2% ($n = 2$)	17.8% ($n = 13$)		
	To a very small extent	0% ($n = 0$)	2.1% ($n = 1$)	4.1% ($n = 3$)		
	To a small extent	2.5% ($n = 2$)	18.8% ($n = 9$)	9.6% ($n = 7$)		
	To an average extent	27.8% ($n = 22$)	33.3% ($n = 16$)	24.7% ($n = 18$)		
	To a large extent	20.3% ($n = 16$)	18.8% ($n = 9$)	30.1% ($n = 22$)		
	To a very large extent	24.1% ($n = 19$)	10.4% ($n = 5$)	2.7% ($n = 2$)		
Value chain	I am not familiar with this concept	35.4% ($n = 28$)	56.2% ($n = 27$)	56.2% ($n = 41$)	Chi-square	*<0.001*
	Not at all	3.8% ($n = 3$)	8.3% ($n = 4$)	13.7% ($n = 10$)		
	To a very small extent	0% ($n = 0$)	0% ($n = 0$)	2.7% ($n = 2$)		
	To a small extent	1.3% ($n = 1$)	2.1% ($n = 1$)	5.5% ($n = 4$)		
	To an average extent	27.8% ($n = 22$)	22.9% ($n = 11$)	19.2% ($n = 14$)		
	To a large extent	16.5% ($n = 13$)	6.2% ($n = 3$)	2.7% ($n = 2$)		
	To a very large extent	15.2% ($n = 12$)	4.2% ($n = 2$)	0% ($n = 0$)		
Knowledge related to recycling centers, renewable energy sources, utilized spaces and access to sustainable services	I am not familiar with this concept	0% ($n = 0$)	0% ($n = 0$)	2.7% ($n = 2$)	Chi-square	*<0.001*
	Not at all	0% ($n = 0$)	8.3% ($n = 4$)	11% ($n = 8$)		
	To a very small extent	0% ($n = 0$)	0% ($n = 0$)	9.6% ($n = 7$)		
	To a small extent	3.8% ($n = 3$)	10.4% ($n = 5$)	20.5% ($n = 15$)		
	To an average extent	22.8% ($n = 18$)	25% ($n = 12$)	24.7% ($n = 18$)		
	To a large extent	32.9% ($n = 26$)	33.3% ($n = 16$)	26% ($n = 19$)		
	To a very large extent	40.5% ($n = 32$)	22.9% ($n = 11$)	5.5% ($n = 4$)		
System thinking	I am not familiar with this concept	2.5% ($n = 2$)	4.2% ($n = 2$)	13.7% ($n = 10$)	Chi-square	*<0.001*
	Not at all	0% ($n = 0$)	2.1% ($n = 1$)	19.2% ($n = 14$)		
	To a very small extent	0% ($n = 0$)	0% ($n = 0$)	0% ($n = 0$)		
	To a small extent	2.5% ($n = 2$)	14.6% ($n = 7$)	4.1% ($n = 3$)		
	To an average extent	21.5% ($n = 17$)	27.1% ($n = 13$)	30.1% ($n = 22$)		
	To a large extent	38% ($n = 30$)	45.8% ($n = 22$)	21.9% ($n = 16$)		
	To a very large extent	35.4% ($n = 28$)	6.2% ($n = 3$)	11% ($n = 8$)		
4 Ps of marketing	I am not familiar with this concept	36.7% ($n = 29$)	56.2% ($n = 27$)	60.3% ($n = 44$)	Chi-square	*0.0011*
	Not at all	2.5% ($n = 2$)	6.2% ($n = 3$)	12.3% ($n = 9$)		
	To a very small extent	0% ($n = 0$)	0% ($n = 0$)	1.4% ($n = 1$)		
	To a small extent	3.8% ($n = 3$)	4.2% ($n = 2$)	5.5% ($n = 4$)		
	To an average extent	21.5% ($n = 17$)	18.8% ($n = 9$)	8.2% ($n = 6$)		
	To a large extent	20.3% ($n = 16$)	10.4% ($n = 5$)	12.3% ($n = 9$)		
	To a very large extent	15.2% ($n = 12$)	4.2% ($n = 2$)	0% ($n = 0$)		
Facilitation skills, change management and group process management	I am not familiar with this concept	30.4% ($n = 24$)	22.9% ($n = 11$)	28.8% ($n = 21$)	Chi-square	*<0.001*
	Not at all	2.5% ($n = 2$)	20.8% ($n = 10$)	16.4% ($n = 12$)		
	To a very small extent	0% ($n = 0$)	4.2% ($n = 2$)	0% ($n = 0$)		
	To a small extent	3.8% ($n = 3$)	6.2% ($n = 3$)	17.8% ($n = 13$)		
	To an average extent	20.3% ($n = 16$)	14.6% ($n = 7$)	17.8% ($n = 13$)		

(*continued*)

Table A1

Competencies	*Scale*	*Cluster 1* (n = *79*)	*Cluster 2* (n = *48*)	*Cluster 3* (n = *73*)	*test*	p-*value*
Natural capital	To a large extent	25.3% (*n* = 20)	22.9% (*n* = 11)	13.7% (*n* = 10)	Chi-square	*0.0016*
	To a very large extent	17.7% (*n* = 14)	8.3% (*n* = 4)	5.5% (*n* = 4)		
	I am not familiar with this concept	26.6% (*n* = 21)	35.4% (*n* = 17)	46.6% (*n* = 34)		
	Not at all	3.8% (*n* = 3)	4.2% (*n* = 2)	17.8% (*n* = 13)		
	To a very small extent	0% (*n* = 0)	0% (*n* = 0)	2.7% (*n* = 2)		
	To a small extent	6.3% (*n* = 5)	12.5% (*n* = 6)	5.5% (*n* = 4)		
	To an average extent	27.8% (*n* = 22)	27.1% (*n* = 13)	16.4% (*n* = 12)		
	To a large extent	24.1% (*n* = 19)	12.5% (*n* = 6)	6.8% (*n* = 5)		
	To a very large extent	11.4% (*n* = 9)	8.3% (*n* = 4)	4.1% (*n* = 3)		

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