

Hologram of Firms with Respect to the Productive Fabric of a Region. A Case of Business Transformation Through Knowledge Transfer in Medellín (Colombia)

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Abstract: The holographic principle states that the whole is contained in each of its parts. In this study, we apply the holographic concept to business studies, with a particular focus on how business transformation might have an impact on the growth of a region. Following an experimental approach, mixed methods research was used to collect descriptive data from a set of firms in Medellín (Colombia). Two measurements (MET1 and MET2) were performed as part of the management model (MM) implemented, which allowed us to quantify the variables defined in the MM. Once a transformation was evidenced, a second measurement was carried out to compare the results and identify improvements in each dimension of the intervened firms. Additionally, the findings of this research (conducted over the course of eight years) were contrasted, from a holographic perspective and per economic sector, with reports on the region's economic growth provided by organisations such as the local chambers of commerce. Through the implementation of an MM developed by the Universidad de Envigado in a set of firms in the region, this study contributes to the literature on how the university impacts the industry through knowledge transfer.

Keywords: Firms, Knowledge management, Knowledge transfer, Management models, SIGET PROS, Business strengthening

1. Introduction

Just as a drop of water contains the characteristics of the ocean, a cell reflects the genetic traits of a living being, and a grain of sand represents the structure of a desert or a beach, each organisational process may be thought of as mirroring the structure of a firm and each firm may reflect the characteristics of the productive fabric of a region.

When applied to business studies, the holographic principle allows the economic development of regions, countries, and sectors to be analysed so that universities can understand the needs of firms and contribute to their strengthening. For this reason, stimulating knowledge transfer (KT) will always be one of the main concerns of universities, which seek to align their mission-related activities with the problems, demands, and interests of society.

The KT approach considered in this study focuses on the role that management models (MMs) play in the transformation of firms, particularly on the implementation of an MM called SIGET PROS by the Universidad de Envigado (IUE). The architecture of this MM is structured into dimensions, which allows for measuring and grouping sets of variables into attributes. Each attribute represents the components of each dimension, and each dimension, in turn, reflects each firm, each sector, and the characteristics of a region. With this, the purpose is to apply the holographic principle to the business field.

In this study, following a holographic approach, each attribute is thus intervened, which has an impact on each dimension and thus results in the strengthening of firms and economic sectors. This, indeed, contributes to the growth of the region where the university operates.

2. Theoretical Framework

2.1 Knowledge Management

Codification, teachability, uncertainty, and complexity are key attributes for KT (Zapata-Cantú et al., 2019) because they enhance its impact (Kogut & Zander, 2003) and reconfigure practices within industries (Sepúlveda-Rivillas et al., 2022). For their part, organisational learning (OL) (Serinkan et al., 2014), organisational knowledge (OK) (Kitapçı & Çelik, 2014), and learning organisation (LO) (Druker, 1993) have been reported to complement knowledge management (KM).

2.2 Knowledge Transfer

Categories such as knowledge sharing, knowledge capture, knowledge creation, and knowledge application flow from the university to the industry (Ibidunni et al., 2020) with varied strategies for their strengthening. In addition, they pose unique challenges to universities and focus on intellectual capital exchange (Hermans & Castiaux, 2007).

Participation, for its part, influences the outcomes and decisions made (De Silva et al., 2022), reshaping the KM practices of actors (Sucena et al., 2022) in addressing challenges through the use of new MMs. KT generates new knowledge (Mazorodze & Buckley, 2020) that is transferrable to all members of an organisation, resulting in process innovation and transformation (Nonaka & Takeuchi, 1995).

Various studies have confirmed the existence of a dynamics in KT, as well as certain limitations associated with the reconciliation between the interests of universities and the needs of firms (Segarra Ciprés & Bou Llusar, 2004). It is noteworthy to emphasise the importance of KM in organisations and its impact on individuals (Lenis, 2015).

2.3 Management Model

MMs are supported by information systems and reinforced by the learning processes of the members of an organisation (Kaiser et al., 2016). Also, they aid in the development of methodologies based on strategies that connect the different components of firms with their environment.

There is a pressing need for MMs that consider the specificities of small and medium-sized businesses (SMBs) (Peña Guarín et al., 2020; Ortega et al., 2021). Given the challenges faced by productive sectors, they require MMs to transform them, which makes the interaction between universities and productive sectors strategic (Rossetti et al., 2020).

SIGET PROS is an MM created by the IUE in collaboration with the Research and Consulting Centre of the IUE. It is based on a study of the SMBs in Medellín (Colombia), which was supported by the Aburrá Sur Chamber of Commerce and began by identifying the characteristics of the business fabric in this region. The design and architecture of SIGET PROS focus on the needs of SMBs as a tool for their strengthening. Additionally, this MM is founded on the concept of complex systems, where different agents interact (Viana Barcelo et al., 2012) to develop projects with strategies for each process. Furthermore, it is structured under the concept of comprehensive organisation (Ortiz & Pedroza, 2006) and includes the following four dimensions: people, management, structure, and environment. These dimensions, in turn, unfold into 13 attributes, and each attribute is further divided into 197 variables.

Considering the holographic principle, a change in any of the components (variables, attributes, dimensions) generates new states of order (Öberg, 2023), which is reflected in the strengthening of SMBs.

- The *People* Dimension

In SIGET PROS, the *people* dimension (PD) constitutes an important competitiveness factor (Ordóñez de Pablos & Lytras, 2008; Harney & Nolan, 2022). It includes three attributes: (i) human management as a competitiveness factor (Kim et al., 2023), (ii) organisational climate as a strengthening element (Xing et al., 2023), and (iii) organisational culture linked to innovation (Pedraza-Rodríguez et al., 2023).

- The *Management* Dimension

In SIGET PROS, the *management* dimension (MD) is crucial for the growth of firms and economies (Ma, 2023). It comprises three attributes: (i) processes, which are drivers of growth (Ramos-Gutierrez et al., 2023), (ii) functions, which play an important role in business sustainability (Macchi et al., 2020), and (iii) institutional philosophy, which embodies values for business creation (Milchram et al., 2019).

- The *Structure* Dimension

In SIGET PROS, the *structure* dimension (SD) encompasses three attributes: (i) finance, which has always been a key performance factor (Klein & Espinoza, 2022; Lerner & Nanda, 2020) requiring a structured management (Zhang et al., 2020); (ii) technology, which acts as a catalyst in organisations and can be applied to all business processes (Ancillai et al., 2023); and (iii) infrastructure and production, which represents a fundamental attribute in operations (Guisse et al., 2023).

- The *Environment* Dimension

In SIGET PROS, the *environment* dimension (ED) serves as a reference for defining business policies and strategies (Wang et al., 2023). It includes four attributes: (i) appropriation of political-legal factors to define a firm's orientation (Li & Jin, 2021); (ii) context to which firms must quickly adapt; (iii) factors associated with socio-environmental aspects (Florez Rios & Morales Sierra, 2019) that meet the demands of the environment; and (iv) aspects related to international trends, which serve as references for strategic design (Ragazou et al., 2022).

2.4 The Holographic Concept in Firms

According to the holographic principle, the whole is contained in each of its parts, just as the parts are contained in the whole (Morín, 2001). In the business field, organisational processes operate on the holographic principle (Al Jamal, 2020; Hall, 1995) similar to how the brain functions (Yazici, 2022). Each part of a firm represents the whole (Khademloo, 2021); hence, when one element is affected, all others are impacted. Likewise, interventions to firms influence the transformation of the productive fabric of a region (Brunetti et al., 2020).

In SIGET PROS, firms are conceived as a 'relational whole' in which specific properties and interdependent characteristics make sense as parts of a hologram. Each dimension represents each element that comprises a firm and allows us to understand each attribute insofar they capture the essence of reality.

2.5 Business Strengthening

The notion of business strengthening (BS) poses, as the greatest challenge, the strengthening of organisational change management (Sancak, 2023). To achieve BS, leadership from within organisations is necessary (Rave-Gómez et al., 2023).

Organisational change must be planned and guided by scientific approaches, especially MMs with defined structures and a methodology with clear and organised steps that engage all individuals in the organisation. Transformations within a firm are linked to its environment and dependent on the changes that may occur in the sector to which it belongs (Mouzas, 2022), just as a network of relationships within and around organisations (Capello & Cerisola, 2023). Furthermore, the outcomes of business transformation (BT) depend on the interventions made in the dimensions that constitute the architecture of the firm (Haftor & Climent Costa, 2023).

Thus, implementing an MM with an architecture that aligns with the characteristics required in the sector and its environment favours a greater impact in achieving business objectives (Worasinchai et al., 2008).

3. Methods

This research, which was conducted over the course of eight years, focused on examining the impact of KT from the university to the industry through the implementation of a set of strategies defined in an MM (SIGET PROS). Following an experimental approach, mixed methods research was used to collect and analyse data from 52 firms in Medellín between 2015 and 2022 (Figure 1). This was done given the complexity of the phenomenon under study (Cameron et al., 2013; Buckley, 2015; De Lisle, 2011) while maintaining academic rigor (Stockman, 2015).

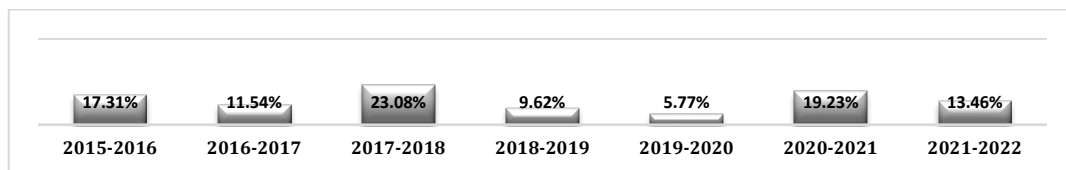


Figure 1: Distribution of Firms by Year

Data collection included two stages: (i) initial diagnosis (MET1) using four techniques (direct observation, document review, interviews, and focus groups), and (ii) measurement and analysis of results with experts from the university and executives from the firms (Magnani et al., 2023) using the Likert scale of SIGET PROS (Table 1).

Table 1: Data Measurement Scale

LEVEL	SCORE	DESCRIPTORS
ADVANCED	8.0–10.0	High levels of achievement, documented evidence, progress in processes, dissemination of information, technological support
VIABLE	6.0–7.9	Some advances, some evidence, adjustable processes, concentrated information, some technological aspects
WARNING	4.0–5.9	Little evidence, failures in processes, poor documentation, obsolete technology, scattered information
RISK	0.0–3.9	Scarce evidence, outdated documents, scarce technology, diffuse information, lack of clarity in processes

Source: Authors' own work.

After data collection, SIGET PROS was implemented in each firm (experimentation phase), which entailed the creation and implementation of a strategic plan. The resulting information from monitoring the variables (MET2) was collected in each firm over a period of six to twelve months.

Table 2: Distribution of Firms by Sector

SECTOR	% OF FIRMS
FOOD SECTOR	11.54%
COMMERCIAL SECTOR	7.69%
INDUSTRIAL SECTOR	32.69%
SERVICE SECTOR	36.54%
TEXTILE SECTOR	11.54%
Total	100.00%

Source: Authors' own work.

One component of this study sought to investigate BT and BS in the economic sectors and productive fabric of the firms under analysis. To that end, the measurements before (MET1) and after (MET2) KT were compared and then analysed against the growth of the sectors in the region.

This paper aimed to provide an analysis, from a holographic perspective, of all the intervened firms and the economic sectors of the region. For such purpose, the following two questions were addressed:

- What transformations are evidenced in the firms after implementing SIGET PROS?
- How are the transformations in the productive fabric of the region reflected in the BS measurements of the firms in which SIGET PROS was implemented?

Figure 2 shows the analysis strategy for comparing the results per sector with the average MET1 and MET2 data. Such analysis includes the dimensions, firms, and economic sectors of the region.

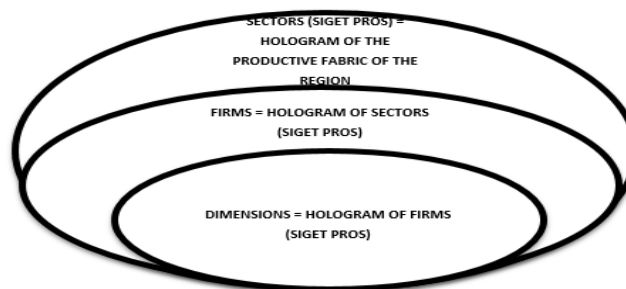


Figure 2: Analysis Strategy Using a Holographic Approach

4. Findings and Discussion

4.1 Results

Figure 3 presents the average measurements provided by SIGET PROS, with the following results for BT: 0.947 for the food sector, 0.939 for the commercial sector, 1.04 for the industrial sector, 0.993 for the service sector, and 1.065 for the textile sector. The percentages shown in Table 3 were calculated using the MET1 data.

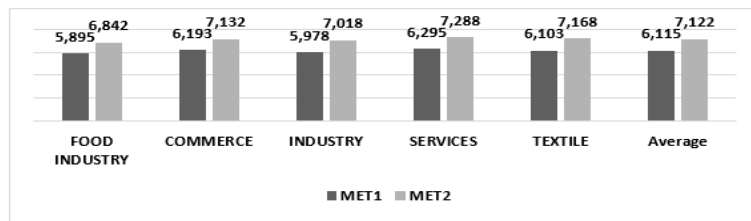


Figure 3: MET1 and MET2 Data by Sector

As shown in Table 3, the difference between MET1 and MET2 data was used to calculate the strengthening percentages of each economic sector when SIGET PROS was implemented, which were distinguished per dimension. By averaging these percentages, it is possible to estimate BT in each sector.

Table 3: Business Strengthening by Sector After Implementing SIGET PROS

% TRANSFORMATION BETWEEN MET1 AND MET2 – SECTORS AND DIMENSIONS					
Sector	BS - FIRMS	BS - PD	BS - MD	BS - SD	BS - ED
FOOD SECTOR	16.061	17.065	28.216	12.329	12.910
COMMERCIAL SECTOR	15.157	13.233	27.146	12.361	14.695
INDUSTRIAL SECTOR	17.398	17.467	48.168	14.512	14.762
SERVICE SECTOR	15.782	17.139	19.171	17.926	22.043
TEXTILE SECTOR	17.440	19.785	17.300	18.811	19.067
Overall average	16.472	17.243	30.092	15.838	17.700

Source: Authors' own work.

During and after the COVID-19 pandemic, the evolution of the region under analysis was characterised by the following:

- It is estimated that, by the end of 2020, the region's economy experienced a negative growth, with a rate ranging between -6% and -7% (Cámara de Comercio de Medellín para Antioquia [Medellín-Antioquia Chamber of Commerce], 2021). As can be seen in Table 4, before the pandemic, most sectors (except for the industrial sector) were experiencing growth.

Table 4: Region's Economic Growth by Sector

YEAR/ SECTOR	FOOD SECTOR	COMMERCIAL SECTOR	INDUSTRIAL SECTOR	SERVICE SECTOR	TEXTILE SECTOR
2016	1.7	7.5	-0.1	2.4	2.1
2017	2.4	1.3	-5.1	3.2	1.4
2018	2.8	4.6	1.5	4.7	2.7
2019	3.2	5.4	-0.4	5.1	4.8
2020	4.2	-4.4	-9.5	-12.0	-22.5
2021	9.9	18.4	20.7	28.1	44.0
2022	4.7	8.0	10.8	12.5	17.6
AVERAGE	4.128	5.828	2.557	7.828	7.157

Source: Authors' own work based on data from the Medellín-Antioquia Chamber of Commerce and FENALCO.

- In the year of the pandemic (2020), only the food sector showed a positive growth; the others experienced a considerable decline in growth. According to estimates, the region's economy experienced a negative growth, with a rate ranging between -6% and -7% (Cámara de Comercio de Medellín para Antioquia [Medellín-Antioquia Chamber of Commerce], 2021)
- All sectors witnessed a strong post-pandemic recovery and, by the end of 2021, showed a significant growth, surpassing 6% (Cámara de Comercio de Medellín para Antioquia [Medellín-Antioquia Chamber of Commerce], 2021). In 2022, all sectors maintained a positive growth trend.

4.2 Discussion of the Results

4.2.1 Analysis using a holographic approach

The proposed analysis outlined in the methodology is illustrated in Figure 4. This figure shows an overlay of the data using the BS values that were estimated based on the difference between the MET1 and MET2 data provided by SIGET PROS and that were compared with the growth rates of each sector in the region. As observed,

each dimension impacts the BS of the firms, and the BS of each firm impacts the BS of the sector to which it belongs, which, following the implementation of SIGET PROS, also impacts the growth of the region.

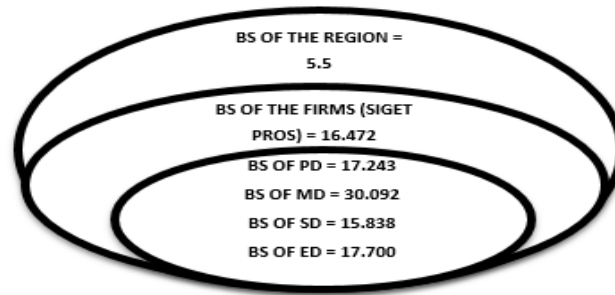
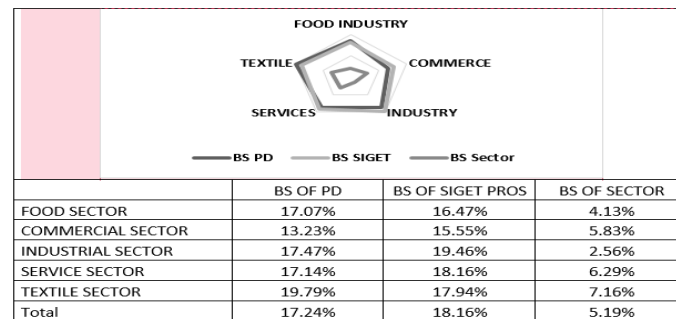


Figure 4: Analysis Strategy Using a Holographic Approach

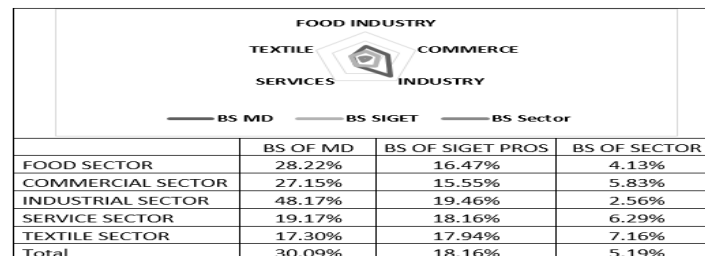
When applying a holographic approach, the results are reflected in the relationships outlined below.

Table 5: Hologram of the People Dimension by Sector



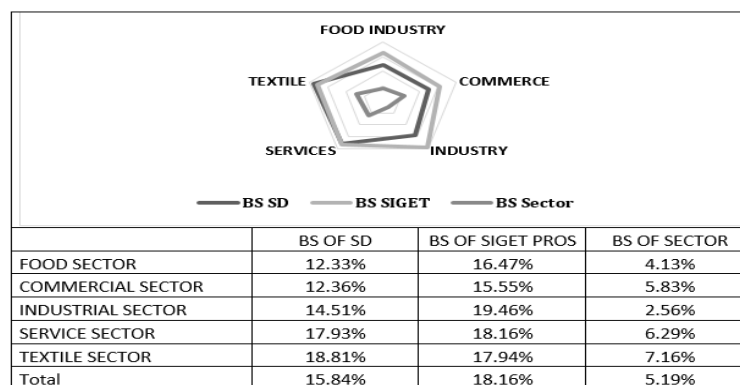
The BS of the PD was found to impact all firms in each sector (Table 5) and to influence the strengthening of the sectors in the region.

Table 6: Hologram of the Management Dimension by Sector



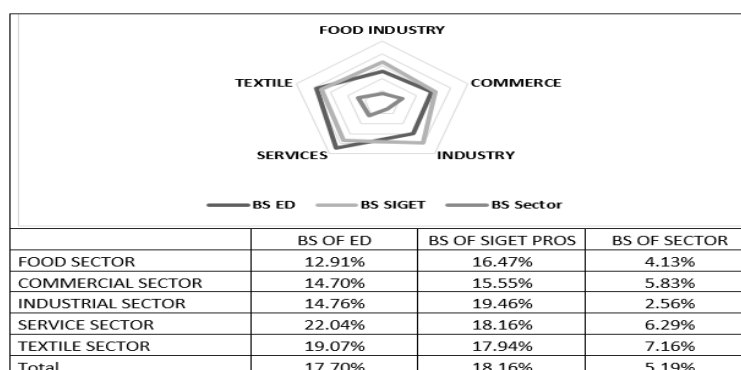
The MD, for its part, showed the highest BS when SIGET PROS was implemented. It was found to significantly impact the firms in each sector, and its effects on the region are evidenced by the growth experienced in the sectors (Table 6).

Table 7: Hologram of the Structure Dimension by Sector



In the SD, only the service and textile sectors exhibited a BS higher than the average value of the firms in the sector. In any event, their contribution to the region's growth is clear, as their growth rate exceeds that of the other sectors.

Table 8: Hologram of the Environment Dimension by Sector



Finally, although the majority of the variables in the ED were external, a significant BS was obtained, contributing to the BS of the firms in all sectors and to the region's growth.

4.2.1 Comparative analysis with other studies

In their study, Sucena et al. (2022) emphasised firms' need for KM and KT, which drives them to implement strategies similar to those considered in our research, such as including the PD, the SD, and the ED.

For their part, Macchi et al. (2020) highlighted the importance of measuring the continuous improvement of firms using reliable techniques. In this study, we measured BT in each dimension and in the firms across sectors by implementing SIGET PROS.

Moreover, Al Jamal (2020) used the holographic principle to analyse how the flow of information influences transformations within firms, allowing the integration of the parts into the whole. This approach is similar to the one considered in the implementation of SIGET PROS, with which we sought to integrate each variable into its respective attribute to thus impact each dimension, firm, and economic sector. As a result of this, the growth of the region's productive fabric is impacted as well.

The BS strategy developed through SIGET PROS (with its architecture structured into dimensions) shares similarities with the proposal of Sancak (2023), who underlines the need to intervene in factors such as governance (the MD), human resources (the PD), technology implementation and financial management (the SD), and customer and supplier management (the ED). In Sancak's study and in our study, firms' possibility of transitioning from their current state to a desired state is a topic of interest.

5. Conclusions and Limitations

The purpose of this study was to analyse, from a holographic perspective, a set of firms and evidence their transformations after implementing an MM called SIGET PROS. Particularly, we were able to evaluate BS through a series of measurements and its contribution to the advancements achieved in each economic sector. The analysis revealed that this is a global concern, and our findings were compared to those of other studies.

We can observe that each sector is strengthened after applying SIGET PROS (Table 3). When comparing the results obtained in the region, the measurements indicate the MM impact on the dimensions, the firms, and the sectors. This is evidence of the holographic vision in the monitoring of the transformations obtained using the MM.

Each transformation accomplished in the dimensions, firms, and sectors under analysis reflect the advancements in the productive fabric of the region; and the estimated measurements, the growth of the different sectors where the IUE operates. This confirms the importance of the strategies applied by universities (through KT) to impact the productive fabric in the regions of influence.

Following the (holographic) analysis approach, the impact of each dimension on the BS of the firms is evident. The BS of each firm impacts the BS of the sector to which the firm belongs, thus impacting the growth of the region.

Consequently, continued work in each of the dimensions of the firms will have an impact on the growth of the sectors, achieving a constant transformation of the regions, as evidenced in the results of each of the dimensions (PD: 17.24%, MD: 30.09%, SD: 15.84%, ED: 17.70%). In all cases, progress is above what has been achieved in the region.

In conclusion, in order to consolidate the KT processes aimed at contributing to the strengthening of the productive fabric of economic sectors and regions, it would be advantageous to keep building trust relationships between universities and firms.

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