

# A system dynamics approach to the balanced scorecard: a review and dynamic strategy map for operations management

Dynamic strategy map for operations management

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## Abstract

**Purpose** – This paper aims to (1) identify the different performance drivers (lead indicators) and outcome measures (lag indicators) investigated in the literature concerning the four balanced scorecard (BSC) perspectives in operations management (OM) contexts and (2) understand how performance drivers and outcome measures (and substantiated perspectives) are related.

**Design/methodology/approach** – We undertake a systematic literature review of the BSC literature in OM journals. From the final sample of 40 articles, performance drivers and outcome measures have been identified, and the relationships amongst them have been synthesised according to the system dynamics approach.

**Findings** – Findings show (1) the most relevant performance drivers and outcome measures within each BSC perspective, (2) their relationships, (3) how the perspectives are linked through the performance drivers and outcome measures and (4) how the different measures relate systemically. Accordingly, four causal loops amongst identified measures have been built, which – jointly considered – allowed for the creation of a dynamic strategy map for OM.

**Originality/value** – This study is the first one that provides a comprehensive and holistic view of how the different performance drivers and outcome measures within and between the four BSC perspectives in OM relate systemically, increasing the knowledge and understanding of scholars and practitioners.

**Keywords** Balanced scorecard, Operations management, Performance management, System dynamics, Systematic literature review

**Paper type** Article

## 1. Introduction

The balanced scorecard (BSC), a strategic performance measurement tool ideated by Kaplan and Norton (1992), has been widely adopted by organisations seeking to turn an organisation's strategy into a set of comprehensive performance metrics across four key areas: financial, customer, internal processes and learning/growth. Its application extends beyond traditional corporate domains as research in operations management (OM) increasingly recognises its value in fostering a holistic and integrated approach to performance evaluation (e.g. Brewer, 2000; Hu *et al.*, 2017, p. 669). In this regard, Kaplan and Norton (1996b, p. 21) also assume that the scorecard should incorporate the complex cause-and-effect relationships amongst performance drivers (lead indicators) and outcome measures (lag indicators) that describe the strategy's trajectory.

However, developing and designing BSC and determining which performance drivers (lead indicators) and outcome measures (lag indicators) is an ongoing debate (Barnabè, 2011).

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Notable BSC critiques include its neglect of certain internal factors, ambiguity regarding the weightage of its perspectives and an oversimplified emphasis on linear relationships between perspectives (Awadallah and Allam, 2015). One fundamental criticism is the BSC's reliance on unidirectional and static relations amongst its perspectives, leading to concerns over the assumed cause-and-effect relationships. The concept of causality in BSC is not extensively explained and, at times, unclear. Nørreklit (2000, pp. 73–74) even posited that the connections in BSC are more logical than causal. Such ambiguities in the BSC can pave the way for misaligned strategies and operational actions (Barnabè and Busco, 2012).

Departing from the above limits, this paper aims to answer the following research questions:

- RQ1. What main performance drivers and outcome measures are investigated in the literature concerning the four BSC perspectives in OM?
- RQ2. How are these performance drivers, outcome measures and substantiated perspectives linked?

Accordingly, we undertook a systematic literature review of the BSC literature in OM journals. We obtained a final sample of 40 articles, which allowed us to identify performance drivers and outcome measures for each perspective. Then, the system dynamics approach and causal loop diagram were applied to detect and synthesise the relationships amongst performance drivers, outcome measures and substantiated perspectives. In this vein, it is worth mentioning that whilst there are several notable prior reviews of BSC literature (see Supplementary Table A1 for details), none consider the role of the BSC for OM as their primary focus nor apply system dynamics.

The primary contributions of this article include (1) determining the foremost performance drivers and outcome measures within each BSC perspective, (2) illustrating their interrelationships, (3) showing empirical evidence on dynamic causality between BSC perspectives through these performance drivers and measures and (4) integrating these loops to create a dynamic strategy map for OM. This map provides a comprehensive view of the multifaceted relationships amongst the four BSC perspectives in OM – representing an extended version of the map by Kaplan and Norton (1996a). In brief, according to the results of our investigation, the different performance drivers and outcome measures within and between the four BSC perspectives in OM relate systematically without a clearly defined hierarchy and not according to trade-offs in dyadic terms.

Section 2 explores the study's theoretical foundation, covering OM, performance systems, BSC and system dynamics. Section 3 details our systematic literature review methodology. Section 4 presents outcomes with causal loop diagrams for each BSC perspective. Section 5 introduces our reimagined strategy map for OM, emphasising the dynamic interactions between the BSC's perspectives. Finally, Section 6 outlines our academic contributions and managerial implications, acknowledging limitations and suggesting future research directions.

## 2. Theoretical background

### 2.1 Operations management

Operations follow a common process of turning tangible or intangible inputs (e.g. physical goods, information and experiences) into outputs; however, the specifics of these inputs and outputs may vary (Schmenner and Swink, 1998, pp. 100–101). Indeed, according to systems theory, “to achieve a target state of the output, the execution of any process requires resources to bring about changes in the state of the flowing elements [. . .] Hence, in its most basic form, a process is modelled as a flowing element interacting with a resource. For example, if the flowing element is a tree trunk, changing into logs for the fireplace, the resources consist of a saw, an axe and human labour” (Dekkers, 2017, p. 118). A further component of the

input-transformation-output process is the 'feedback information,' which controls the input-transformation-output process (Fowler, 1999, p. 184).

Within this context, OM orchestrates the interconnected elements of the input-transformation-output process (Barnes, 2018). It holds significance across the entire organisation, offering principles, concepts, approaches and techniques that grasp value for managers. In particular, this includes sourcing products and services from suppliers and ensuring their smooth delivery to customers, collaborating seamlessly with other organisational functions, providing a continuous operational flow and fostering internal efficiency (Radnor and Barnes, 2007).

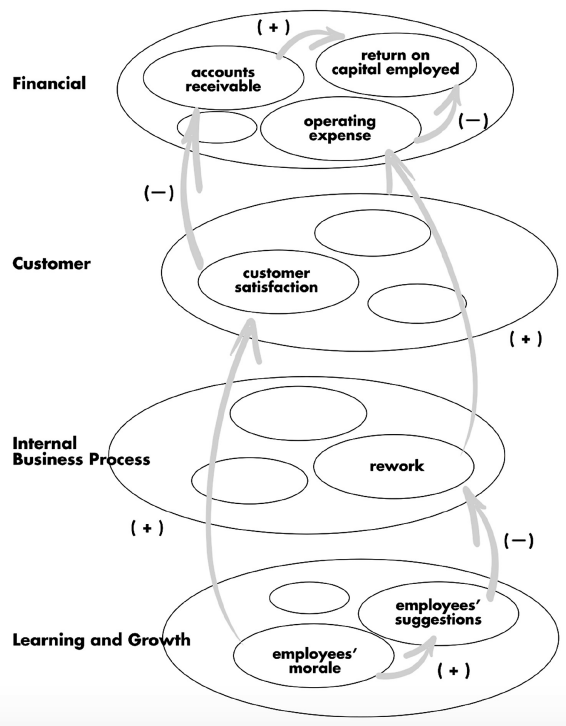
### 2.2 Performance measurement system and the balanced scorecard

By quantifying performance metrics, operations managers can set benchmarks, track progress and drive continuous improvement efforts, ultimately enhancing productivity, reducing costs and delivering better customer value (Bititci *et al.*, 2012). Amongst several performance measurement systems developed to match internal operations capabilities with external market requirements, one of the most well-known and accepted performance measurement system tools is the BSC, established by Kaplan and Norton in 1992. The relationship between its four perspectives – financial, customers, internal and learning and growth – can be synthesised as follows. *Learning and growth* of employees' skills and abilities allow the development of processes that may lead to increased effectiveness in *internal* operations. This, in turn, enhances the value provided to the *customer*, which is then converted into improved *financial* results (Kaplan and Norton, 1996a). Therefore, these perspectives allow companies to monitor short-term financial results whilst tracking the progress and performance of intangible assets that generate growth for future financial performance.

The four perspectives can be represented as an interlinked bottom-up hierarchy, called *strategy map* (see Figure 1), and their performance drivers and outcome measures should be linked in cause-and-effect relationships (Kaplan and Norton, 2004, p. xii). Operating as lead indicators, performance drivers are peculiar to a particular business unit, albeit oriented towards those universal objectives. Instead, the outcome measures, such as profitability and customer satisfaction, frequently operate as lag indicators. This is a practice-oriented distinction, but *there is no insurmountable separation between lead and lag indicators*. Instead, each business chooses which measures are lag and lead for itself according to its objectives, fields of competition, resources and so on. For instance, Kaplan and Norton (1996b, p. 21) consider employee satisfaction as a generally used lag indicator, whilst several field contributions depict employee satisfaction as a lead indicator of customer satisfaction (e.g. Macpherson, 2001, p. 17). Definitively, a genuinely working BSC should include and coordinate both performance drivers and outcome measures.

In this respect, studies have confirmed the key assumptions of the BSC and its validity as (1) deploying strategic intent into single objectives and measures linked to the four different perspectives (Otley, 1999, p. 375), (2) creating consensus about the strategy required to generate organisational integration (Lipe and Salterio, 2000, p. 285) and (3) integrating outcome measures (lag) and the performance drivers of outcomes (lead), linked together in cause-and-effect relationships horizontally within and between areas (Butler *et al.*, 1997, p. 247). Accordingly, the BSC works not just as a measurement system, but integrates non-financial measurements in a strategic control framework to support the value creation process in organisations (Bourguignon *et al.*, 2004, p. 115).

The characteristics of the BSC in terms of strategy execution and management also suggest potential benefits for companies in OM (Carmona and Grönlund, 2003). Indeed, the BSC can improve organisational activities by (1) translating strategy into operational goals, framing objectives comprehensively, (2) understanding relationships amongst performance



Source(s): Kaplan and Norton (1996b, p. 46)

Figure 1.  
The strategy map by  
Kaplan and Norton  
(1996b, p. 46)

drivers and outcome measures and (3) involving employees through a systematic evaluation of role clarification.

Nevertheless, the BSC has been criticised in terms of effectiveness and efficiency, in particular, its inability to move plans and strategies into action in a timely way (Barnabè, 2011; Bianchi and Montemaggiore, 2008), due to its difficulty in fully integrating the effect of dynamics within a system. In particular, Nørreklit (2000, p. 78) highlights the absence of cause-and-effect relationships between measures from the four perspectives. Although the connections are likely interdependent, Kaplan and Norton (1992) refer to finality, not causality. This suggests that the fundamental assumption underpinning the BSC needs to be refined.

To this end, a further step has been introducing a second- and third-generation BSC (Lawrie and Cobbold, 2004) based on the development of the strategy map initially proposed by Kaplan and Norton (1996a). Here, a diagram provides a deeper causal analysis amongst performance drivers and outcome measures, highlighting the value creation process by connecting strategic goals in relationships in the four BSC perspectives. Barnabè (2011, p. 468) emphasises that links between BSC perspectives are interdependent and illustrates the dynamic nature of the system based on the strategy map. We will advance this insight by proposing diagrams and a strategy map.

There have been several attempts to develop *dynamic* BSC across different settings within organisations (e.g. Bianchi and Montemaggiore, 2008). These have been primarily designed to consider the feedback loop approach and mainly tested against real-world data (Akkermans and Van Oorschot, 2005). These different practical developments, applying the tracking of dynamic relationships between the four BSC perspectives, may provide OM

research with a relevant theoretical base to develop a dynamic strategy map for organisations. As suggested by [Oladimeji et al. \(2021\)](#), a structured system dynamics approach to performance management can help organisations strategically achieve their goals and support decision-makers by moving from a static to a dynamic view to show causality, systemic connection, time delay and interrelationships. In other words, BSC advancements based on a system dynamics approach aim to demonstrate that matching the traditional BSC architecture with system dynamics principles offers better support for strategic management decisions ([Barnabè, 2011](#); [Supino et al., 2019](#)) and is also relevant to operational studies (e.g. [Cunha Callado and Jack, 2015](#)).

### 2.3 The system dynamics approach

In 1961, the seminal book *Industrial Dynamics* by Jay W. Forrester brought to light the system dynamics approach [1]. The system dynamics approach is “a perspective and a set of conceptual tools that enable us to understand the structure and dynamics of complex systems” ([Sterman, 2000](#), p. 6), it was advanced to help executives gain a more in-depth understanding of newly framed complex contexts. More recently, [Dekkers \(2017, p. 285\)](#) defined system dynamics as “an approach to understanding the behaviour of complex systems over time. It is mainly based on internal feedback loops and time delays that affect the entire system’s behavior. Generally, it is applied to analyse any dynamic system characterised by interdependence among elements, mutual interaction between actors and elements, feedback loops, and circular causality”. In other words, the system dynamics approach highlights a continuous view of the organisation that uncovers system behaviour and the structures underlying discrete decisions ([Forrester, 1961](#)). In particular, the system dynamics approach focusses on understanding the behaviours of complex systems, which are usually composed of components in circular interlocked relationships ([Forrester, 1994](#)). Such circular causality concerns the influence of component A on component B, which in turn influences a component C that affects the original component A, thus, determining a circular A-B-C relationship. To estimate the impact of a given corporate strategy, the system dynamics approach can help identify *ex ante* complex situations where unpredictable causes generate unplanned effects, allowing managers to handle those situations effectively ([Barnabè, 2011](#)). Methodological steps for applying system dynamics can be summarised as follows ([Sterman, 2000](#); [Shaik and Dhir, 2021](#)).

- (1) *Defining the problem/situation*: defining the problem/situation and the system’s boundaries.
- (2) *Identifying the variables and their relationship*: defining the crucial component of the system and depicting the causal relations amongst them through causal maps that also identify positive or negative feedback and/or delays.
- (3) *Modelling*: using qualitative and quantitative tools, such as diagramming tools, stock and flow maps and causal loop diagrams to model system dynamics. Causal loop diagrams successfully depict system dynamic-based BSC (e.g. [Bianchi, 2016](#); [Supino et al., 2019](#)); it consists of nodes (i.e. variables) and edges (i.e. causal links between variables). A positive link means two nodes change in the same direction; if the node in which the link starts decreases, the other node decreases and vice versa. A negative causal link means the two nodes change in opposite directions: if the node where the connection starts increases, the other node decreases and vice versa.
- (4) *Verifying, validating and simulating the model*: ensuring the validity of the system dynamics model for its predetermined use. For this purpose, the system dynamics model may be submitted to different types of validation tests, such as the classic statistic test, technical validation, or case studies ([Barlas, 1989](#); [Barnabè, 2011](#)).

- (5) *Analysing the results*: understanding the future behaviour of the system and designing policies that can help the system to work better.

The system dynamics approach has also been advocated by [Kaplan and Norton \(1996a, p. 67\)](#) as suitable for BSC research: “the Balanced Scorecard can be captured in a system dynamic model that provides a comprehensive, quantified model of a business’s value creation process”. Identifying the dynamics amongst the four BSC perspectives can facilitate the systemic approach of OM and has implications for managers seeking to enhance organisational performance ([Kaplan, 2009](#)). In other words, the system dynamics approach for the BSC (1) enables understanding of interrelated dynamic relationships amongst performance drivers and outcome measures, (2) elicits mental models and sharing knowledge amongst organisational agents, (3) allows better dissemination of strategy to both managers and staff, (4) permits the identification of the potential consequences of management policies and (5) provides a better linkage between the performance measurement system and organisational strategy.

[Nielsen and Nielsen \(2015, p. 1\)](#), combining elements from traditional BSC with systems thinking, suggest a shift from a static to a system dynamics approach to the BSC. However, these authors do not consider the several dynamic relationships existing within and between the four BSC perspectives when implemented in the OM field – as also claimed in recent system dynamics and BSC contributions ([Oladimeji et al., 2021](#); [Tawse and Tabesh, 2022](#)).

### 3. Methodology

#### 3.1 Research design

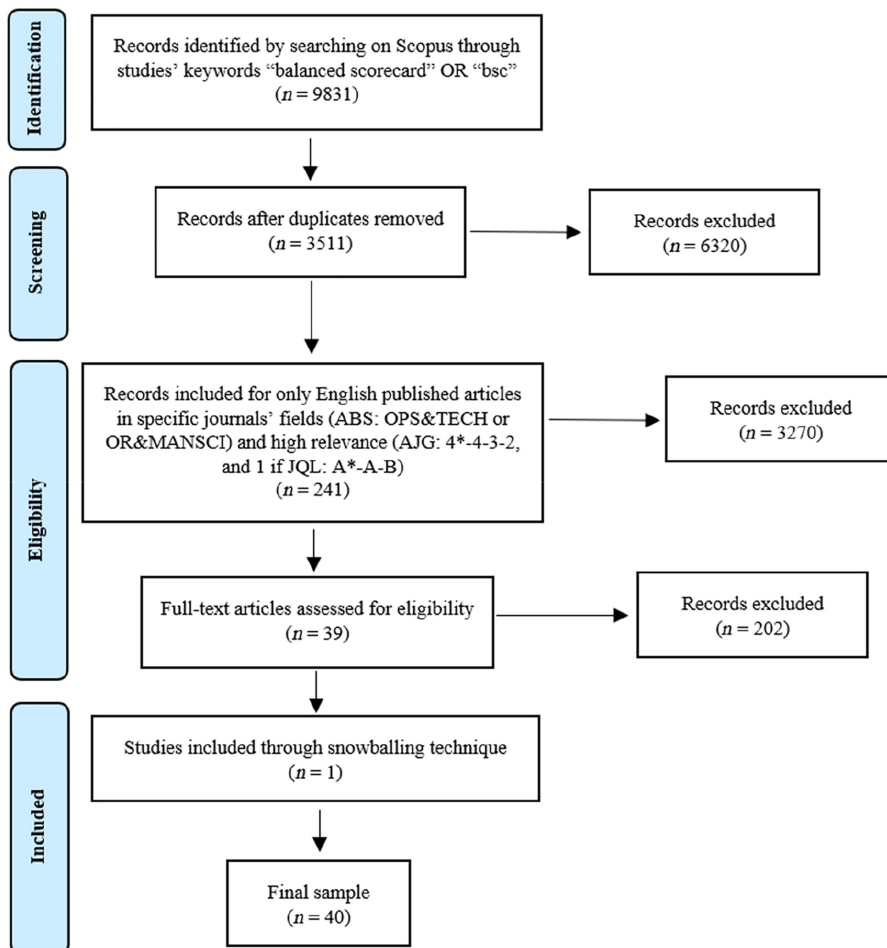
The systematic literature review method was chosen because, unlike traditional narrative reviews, it “locates existing studies, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in such a way that allows reasonably clear conclusions to be reached about what is and is not known” ([Denyer and Tranfield, 2008, p. 671](#)). In this article, such a rigorous and reproducible method is employed to shed light on the multiple dynamic relationships within and between the four BSC perspectives when implemented and used as a strategic tool in OM.

#### 3.2 Article selection and analysis

This systematic literature review follows authoritative guidelines (i.e. [Tranfield et al., 2003](#); [Denyer and Tranfield, 2008](#)) and related applications (e.g. [Cristofaro and Giannetti, 2021](#); [Heinis et al., 2022](#)). To transparently report the purpose, methodology and findings of our review, we adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement – a comprehensive guideline crafted by [Page et al. \(2021\)](#) that outlines the steps for selecting, assessing and synthesising studies in systematic reviews. The PRISMA guidelines include a five-phase flow diagram (see [Figure 2](#)). The five steps are (1) identification, (2) screening, (3) eligibility, (4) inclusion and (5) data extraction and analysis. The checklist includes items deemed essential for the transparent reporting of a systematic review; questions within the list are broadly divided into the following categories: title, abstract, introduction, methods, results, discussion and other information.

Consistent with [Tranfield et al. \(2003\)](#), we selected articles for the systematic literature review as follows.

- (1) *Identification*. The databases used for the literature search were (a) Business Source Premier (EBSCO), (b) ProQuest’s ABI/Inform, (c) Web of Science and (d) Scopus. Only peer-reviewed journal articles published in English were included. The research was not restricted to a given starting period; the end date was 1 September



Source(s): Authors work

**Figure 2.** PRISMA framework to report the systematic literature review protocol

2023. Selected articles were required to contain at least one of the following words within titles, keywords and/or abstracts: “balanced scorecard” OR “BSC” OR “scorecard” (similarly to other BSC systematic literature reviews, e.g. Hansen and Schaltegger, 2016). From this, 9,831 contributions emerged.

- (2) *Screening.* Duplicates from databases were eliminated at this stage, resulting in 3,511 contributions.
- (3) *Eligibility.* The following eligibility criteria were applied to focus on articles in the OM field and ensure the retrieved documents’ relevance and quality. Only articles published in journals ranked in the field of “Operations and Technology Management” (OPS&TECH) or “Operations Research and Management Science” (OR&MANSCI), according to the Academic Journal Guide (AJG) 2021, were selected.

Then, we eliminated articles not published in journals ranked 2, 3, 4 and 4\* in the AJG 2021; [Hristov et al., \(2021\)](#). This step ensured a certain level of academic rigour for filtered publications. Moreover, to observe a relatively unbiased procedure, we also considered journals ranked 1 in the AJG 2021, whether contextually classified as A\*, A, or B in the Journal Quality List (JQL) 2021; see Supplementary [Table A3](#) for the comparison. After applying these eligibility filters, our sample consisted of 241 articles. These were fully read to ensure their alignment with the research objective. Following the approach adopted by [Poggesi et al. \(2016\)](#), the 241 articles were reviewed according to two quality assessment criteria: (a) theoretical robustness and (b) methodological robustness. For both requirements, all authors assigned scores to each article ranging from one (lowest value) to three (highest value). Articles with scores less than or equal to three were excluded from the sample. The inter-rater reliability for this assessment was high (Cronbach's Alpha = 0.87). This phase led to a final sample of 39 articles.

- (4) *Inclusion.* The snowballing technique was adopted to consolidate the research outputs and one article was added. The final sample was composed of 40 articles.
- (5) *Data extraction and analysis.* For each article, we retrieved the following information: (a) authors, (b) journal, (c) year of publication, (d) type of article, (e) context of the study, (f) data collection procedure, (g) data analysis procedure, (h) main findings and (i-j) performance drivers or outcome measures [including the adopted key performance indicator (KPI)]. Note that indicators are selected two by two, thus considering their relationship and that neither a minimum nor maximum limit was applied to the number of coupled indicators retrievable from each article reviewed; (k) polarity of the relationship (“+” or “-”) between indicator 1 and indicator 2; (l) main results associated with the indicators 1 and 2 relationship; (m) the direction of the relationship; (n) BSC perspective related to the relationship between indicators 1 and 2; (o) the notation within the related causal loop diagram; and (p) the strength of the relationship (“moderate” for relationships identified in one article amongst those reviewed, “substantial” for relationships identified in two articles, “strong” for relationships identified in three or more articles). See Supplementary [Tables A2](#) and [A4](#)
- (6) *Data analysis.* The system dynamics analysis was implemented according to the following four-step procedure (see also [Supino et al., 2019](#)):
- (7) Two authors read each article separately, reporting in a detailed worksheet (see Supplementary [Table A4](#)) the couples of indicators (indicators 1 and 2) for each article that substantiate OM influences, connecting each indicator to a specific BSC perspective according to its main area of impact;
- (8) The polarity, direction and strength of the relationship between the two indicators were identified, linking indicators in the feedback loop by causal connections that can be charged with a polarity to determine the type of effect, that is, a positive polarity (“+”) for a straight influence and a negative polarity (“-”) for an inverted relationship, helping to determine causal relationships between two indicators, for example, A positively influences B;
- (9) Considering the specific BSC perspective connected to the extracted and studied indicators, we aggregated, two by two, the indicators’ relationships, helping form a causal loop diagram for each BSC perspective by hypothesising each loop’s start and end from a specific outcome measure according to its potential causality (see



Barnabè, 2011) and then classifying feedback loops into two types, positive and negative. *Positive* (or *reinforcing*, “R”) loops intensify the dynamics emerging within a system (i.e. if the cause increases, the effect increases above what it would otherwise have been, and if the cause decreases, the effect decreases below what it would otherwise have been). In contrast, *negative* (or *balancing*, “B”) loops balance the dynamics within a system (i.e. if the cause increases, the effect decreases below what it would otherwise have been, and if the cause decreases, the effect increases above what it would otherwise have been) (Sterman, 2000);

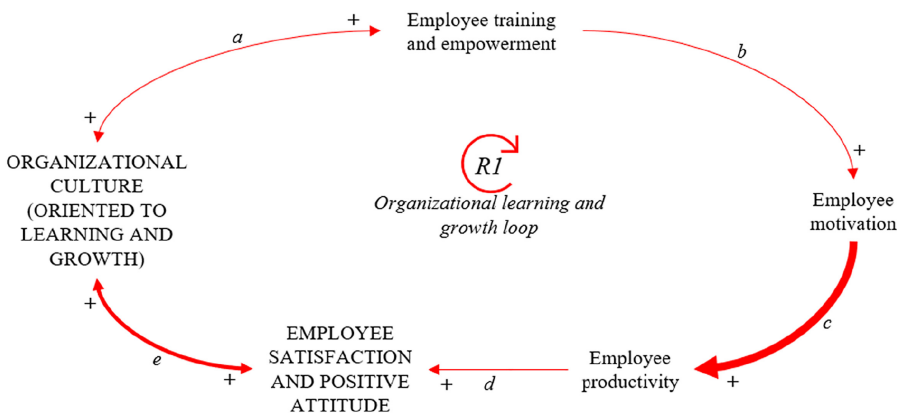
- (10) We aggregated causal loop diagrams to form a dynamic strategy map for OM by first identifying the articles that analysed relationships amongst indicators belonging to different BSC perspectives (which we term “outward relationships”), then analysing the relationships’ causality in terms of direction and polarity (see Supplementary Table A5), and finally, aggregating the already drawn causal loop diagrams considering those ‘bridging’ connections.

### 4. Results

In this section, we depict the causal loop diagram for each BSC perspective through Figures 3–6. Graphically, outcome measures are written in uppercase, whilst performance drivers are in lowercase. Lowercase letters amongst indicators (i.e. notation; a, b, c, etc.) indicate the logical order of the relationships depicted. Moreover, the strength of the relationships (as reported in column *p* of Supplementary Table A4) is indicated through different thicknesses of the connections, namely a strong relationship between indicators is shown by the thickest line, a substantial relationship by a line of medium thickness and a moderate relationship by the least thick line.

#### 4.1 Learning and growth dynamic perspective

The BSC learning and growth perspective includes objectives mainly expressed by employee-based indicators. These indicators were then retraced and connected, as extensively reported in Supplementary Table A4, then depicted within a dynamic system reported here through the causal loop diagram in Figure 3. The first reinforcing loop generated in this analysis (R1) is named “Organisational learning and growth loop”, which starts from and culminates in the

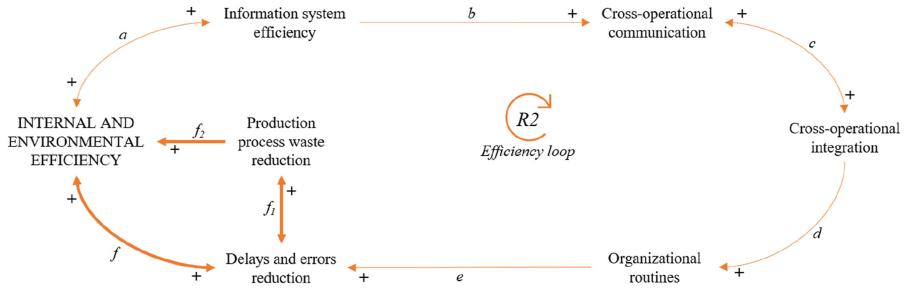


Source(s): Authors work

Figure 3. Learning and growth dynamic perspective of the BSC in OM

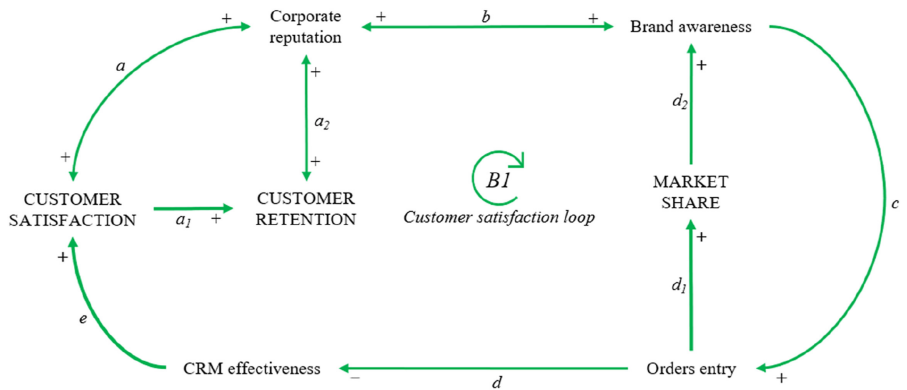
outcome measure *organisational culture (oriented to learning and growth)*, including three unidirectional and two reciprocal positive relationships.

Organisational culture incorporates essential elements, such as trust, commitment, collaboration and competencies, to create virtuous dynamics within the learning and growth



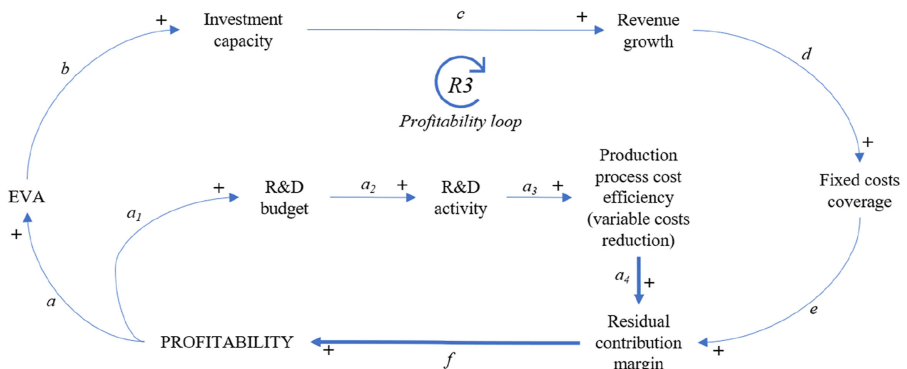
**Figure 4.**  
Internal processes  
dynamic perspective of  
the BSC in OM

Source(s): Authors work



**Figure 5.**  
Customer dynamic  
perspective of the BSC  
in OM

Source(s): Authors work



**Figure 6.**  
Financial dynamic  
perspective of the BSC  
in OM

Source(s): Authors work

perspective centred on people's skills and tasks. Thus, central to an *organisational culture (oriented to learning and growth)* is *employee training and empowerment* and, consequently, employees' technical and human improvements may be valued by the organisation's members who, in turn, trust and reinforce that *organisational culture* (Albuhisi and Abdallah, 2018). Once a good level of *employee training and empowerment* is reached, it improves *employee motivation* (Akkermans and van Oorschot, 2005) as an enhanced positive psychological attitude toward their tasks strongly increases *employee productivity*. The positive influence of *employee motivation* on *employee productivity* is particularly valuable given its generalisability. Indeed, this relationship is detectable in different types of organisations, both large (Akkermans and van Oorschot, 2005) and small (Quezada *et al.*, 2014) and in both service (Akkermans and van Oorschot, 2005) and product (Singh *et al.*, 2018) organisations. Increasing employees' productivity means improving the company's capacity to fulfil tasks requested and, moderately, even enhancing *employee satisfaction and positive attitude* toward the work done (Akkermans and van Oorschot, 2005). Also, organisational culture creates a stimulating work environment where employees generally feel more satisfied and optimistic. Employee satisfaction supports people expressing those positive attitudes and aims at developing the desired organisational culture to restart the loop (Decoene and Bruggeman, 2006).

#### 4.2 Internal processes dynamic perspective

The internal processes perspective identifies those processes where the organisation must excel in satisfying customers and shareholders over time (Kaplan and Norton, 1992); thus, procedures aim to deliver outstanding value to end users whilst maintaining the highest possible internal efficiency. Starting from and ending with the outcome measure *internal and environmental efficiency*, the causal loop diagram of the internal processes perspective – extensively explained in Supplementary Table A4 and depicted in Figure 4 – identifies three positive reciprocal relationships and five positive unidirectional relations within the second reinforcing circle of this analysis (R2), named *efficiency loop*.

The internal efficiency of organisations involves appropriately utilising both tangible and intangible assets, including information. Hence, improved interior and environmental efficiency may support timely and correct information flow, measured by *information system efficiency* (Okongwu *et al.*, 2015). Vice versa, once the organisation is provided with an efficient information system, it can increase its final level of *internal and environmental efficiency* (Okongwu *et al.*, 2015) as actors in the production chain encounter correct and timely information to reduce those misalignments usually associated with consumption and costs. The efficient information system may also benefit good *cross-operational communication* (Aliakbari Nouri *et al.*, 2019), attempting to lead to *cross-operational integration* (Andersen *et al.*, 2004). Indeed, all those activities that need to be completed with the participation of different operational levels (or departments) require prompt intersecting communications to pursue their integration (Andersen *et al.*, 2004). Then, repeated interactions amongst operational levels (or departments) naturally create *organisational routines* over time (Andersen *et al.*, 2004). Indeed, routines can generate standardised practices to be adjusted day-by-day to address *delays and errors reduction*, which is quantified explicitly as a reduction in the differences between the due date-actual date and expected delivery-actual delivery by Supino *et al.* (2019) in the case of an e-commerce implementation project. Reducing errors means fewer undelivered and returned product ratios, resulting in *waste reduction* (Brewer, 2000). In parallel, these efficient dynamics generate outstanding results in customer deliveries and waste reduction, determined as recycling rates by Reefke and Trocchi (2013), both determining positive levels of *internal and environmental efficiency* (Ferreira *et al.*, 2016). In turn, *delays and errors reduction* is relevant

to improving *internal and environmental efficiency*. In particular, reducing errors involves reducing waste, production cycle times and costs due to returned products, whilst reducing delays consists of reducing costs due to stretched delivery times (Chand *et al.*, 2005). Once the firm has figured out these operational issues and reached a convincing internal and environmental efficiency level, the loop may restart with the reinforced mechanisms.

#### 4.3 Customer dynamic perspective

The causal loop diagram of the customer perspective comprises indicators creating the fundamentals that show customers the company's value proposition (Kaplan, 2009). In balancing the *customer satisfaction loop* (B1) identified in Figure 5, three positive reciprocal relationships, five positive unidirectional relationships and one negative unidirectional relationship – each explained in detail in Supplementary Table A4 – start from and end with the outcome measure *customer satisfaction*.

Even though the content of the value proposed outwardly differs between companies, *customer satisfaction* most likely increases *corporate reputation* in customers' minds. Vice versa, final users directly express the overall favourable assessment of the company's reputation in the market through measures like *customer satisfaction* (Barnabè, 2011). Nevertheless, for the organisation, these sustained levels of appreciation are significant when stable economic relationships are achieved by retaining customers (Goharshenasan *et al.*, 2022). Therefore, *customer retention* may be exploited by firms to reinforce corporate reputation further, still considering the positive influence that the latter has on the former (Nielsen and Nielsen, 2012). Companies want to obtain sustained sales from their relationship with their audience. Hence, a positive *corporate reputation* is built to pursue a self-reinforcing association with corporate *brand awareness* in the relevant market (Reefke and Trocchi, 2013). Indeed, the presence of a specific offer on the market likely allows the organisation to increase its *market share*, widely estimated by the percentage of a market segment served by the firm and then a more extensive awareness of the value proposition in the market (Hu *et al.*, 2017). This allows the organisation to be more in touch with customers, the management of whom often relies on customer relationship management (CRM) systems. An effective CRM, namely keeping relationships with customers and analysing their preferences over time, positively affects *customer satisfaction*. In particular, *customer satisfaction* does not derive from the CRM effect on product-service quality, which is still debated (Okongwu *et al.*, 2015), but rather from the CRM effect on the creation of reciprocally satisfying relationships with customers (Reefke and Trocchi, 2013). Nevertheless, *CRM effectiveness* may decrease when orders rise to high levels, especially if inexperienced and derived from different market segments (Okongwu *et al.*, 2015). *Customer satisfaction* can 'reopen' the whole loop at this final stage.

#### 4.4 Financial dynamic perspective

This final perspective comprehensively evaluates the financial aspect dynamics. Hence, Figure 6 shows the fourth reinforcing loop in this analysis (R3), named the *profitability loop* with the highest number of connections (ten positive unidirectional, all explained in Supplementary Table A4). The loop's beginning and end lie in the outcome measure *profitability*.

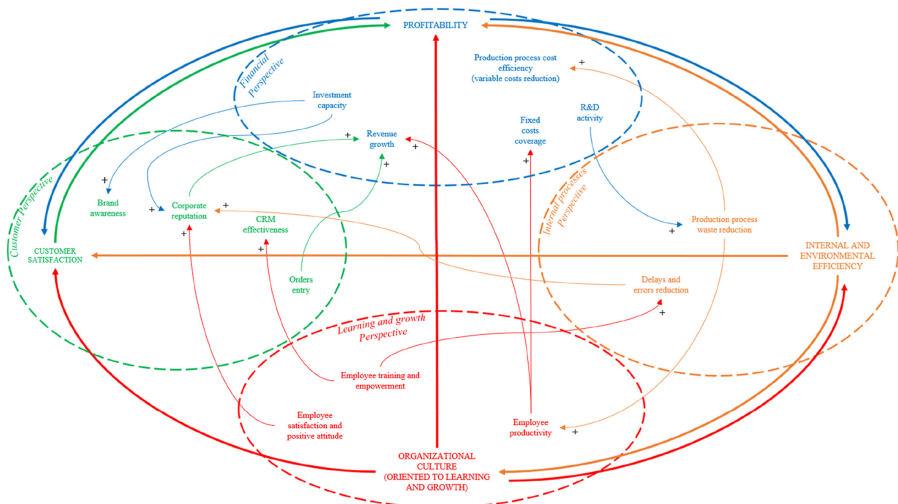
Improving the capacity of people and systems to operate efficiently is crucial to sustain outstanding economic results. Investments authorised within the *R&D budget* can assume a strategic relevance, as in the Swedish electrical engineering company considered by Nielsen and Nielsen (2012). Indeed, as *R&D activity* comprises creative and systematic work undertaken to increase knowledge stock and devise new applications of available knowledge, such companies generally systematically report lower variable costs (Aliakbari Nouri *et al.*,

2019). Nevertheless, such innovation-driven changes do not always optimise the production process. Rather, it is conditioned to the firm's characteristics and the industry where it operates. For example, the empirical outcomes of Lee and Kang (2007) offer a partial endorsement of the concept that the variety of innovation impacts productivity growth. Their findings point out that, in the short term, process innovation could yield more substantial strides in productivity compared to product innovation. This observation stems from the divergence in efficiency progression when deconstructing productivity growth into two key components: efficiency growth and technical growth. To elaborate, product innovation inherently involves the creation of novel products and revolutionary changes, which could impede efficiency growth to a greater extent than other forms of innovation due to the intricacies involved in product development and the necessary adaptations for "innovations." Conversely, process innovation is directed towards minimising defects, shortening lead times, curtailing costs and addressing other factors, rendering it strongly oriented towards augmenting efficiency. Consequently, it significantly contributes to the enhancement of efficiency growth.

Expanding upon the insights outlined earlier, it becomes clear that the intricate interplay between various types of innovation and their ramifications for productivity growth holds profound implications. As underscored by Voelpel *et al.* (2006, p. 53), the character of innovation tied to *R&D activities* is undergoing a transformation from incremental to disruptive, from closed to open and is increasingly becoming network-driven. This shift towards companies embracing strategic connections, sharing knowledge and adopting transformative practices carries escalating significance. Therefore, organisations seek to embrace *production process-cost efficiency (variable costs reduction)* with their final intention to increase general *profitability*, and this relation is measured by *residual contribution margin* (Dror, 2008). The positive economic result increased the economic value added (EVA) calculation, which, assuming stability of the cost of capital, may contribute to enforcing corporate *investment capacity* (Hu *et al.*, 2017). As firms are usually supposed to be part of a competitive economy, their investment capacity will be exploited to improve their fixed assets. More productive machines and bigger plants allow the firm to pursue *revenue growth*, generally determined as a positive difference between current and past revenues (Hu *et al.*, 2017). In addition, such an increase in revenues could improve *fixed cost coverage*, which is compensation for the stable economic efforts of the firm (Supino *et al.*, 2019). Then, as the contribution margin is the excess between the selling price of the product and total variable costs, the residual may be used to cover fixed costs (which are covered at the break-even point) (Cunha Callado and Jack, 2015). After the break-even point, an increase in the *residual contribution margin* can be translated into profit relevant to profitability indexes (Tjader *et al.*, 2014), then restarting the *profitability loop*.

## 5. A system dynamics approach to the BSC in OM

In this section, we propose an extension of the strategy map for OM. Consistent with Nørreklit (2000), we show that the relationship between the BSC perspectives is more likely to be interdependent. This map identifies dynamic relationships amongst the performance drivers and the outcome measures of the four BSC perspectives and reconsiders them as a system characterised by complex patterns (see Figure 7). The relationships between BSC perspectives are defined as "outward relationships", thus generated by "outward indicators." Lead indicators of one BSC perspective that influence other lead indicators of other BSC perspectives are represented in lowercase and fine arrows (see Figure 7). Amongst such outward indicators, we include an indicator originally considered an outcome measure (i.e. employee satisfaction and positive attitude) that, in Figure 7, takes on a performance driver function because it positively influences another performance driver (i.e. corporate



**Figure 7.**  
System dynamics  
relationships amongst  
BSCs perspectives  
according to reviewed  
papers

**Note(s):** The arrows are colored according to the CLD of the BSC perspective they start from

**Source(s):** Authors work

reputation). The outward relationships amongst performance drivers are synthesised and represented through bold arrows that connect the four BSC perspectives' outcome measures. The arrows are coloured according to the causal loop diagram of the BSC perspective they start from. In total, 13 positive unidirectional relationships were found amongst performance drivers. In contrast, three reciprocal and one unidirectional relationship were found amongst outcome measures of different BSC perspectives (see Supplementary Table A5 for full description).

We note five outward relationships starting from the causal loop diagram of the learning and growth perspective. *Employee satisfaction and positive attitude* may be seen as an outward indicator of improving *corporate reputation* (from the customer perspective) by diffusion of positive employee experience to the business audience (Akkermans and van Oorschot, 2005). Then, the training offered to employees is connected to two critical outward relationships. Indeed, higher levels of *employee training and empowerment*, on both operational and relational abilities, enhance, respectively, quality deliveries (measured through *delays and errors reduction* from an internal process perspective) and relationships with customers (measured through *CRM effectiveness* from a customer perspective) (Chand et al., 2005; Okongwu et al., 2015). From the financial perspective, two more outward effects are produced by employee productivity. First, productive employees are better at using corporate fixed tangible and intangible assets, allowing the firm to raise *fixed costs coverage* related to their utilisation (Quezada et al., 2014). Second, productive employees speed up the processing of incoming orders, thus allowing new orders to be processed and sustaining *revenue growth* (Akkermans and Van Oorschot, 2005). The described relationships confirm the central role assumed by the learning and growth perspective within the structure and functioning of the BSC. The reinforcing outward effects are directed from the outcome measure *organisational culture* (from the learning and growth perspective) to all the other outcome measures, namely *internal and environmental efficiency* (from the internal processes

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perspective), *customer satisfaction* (from the customer perspective) and *profitability* (from the financial perspective).

Using *waste reduction*, the causal loop diagram of the internal processes' perspective influences the causal loop diagrams of two other perspectives. First, as substandard products are typically wasted and reprocessed, reducing this phenomenon consequently allows for cutting time and reducing mistakes in deliveries – with final positive outcomes on *employee productivity* (learning and growth perspective). Second, reducing wasted and reprocessed products inevitably lowers costs (financial perspective), especially variable costs, because they are directly linked to the number of manufactured items (Brewer, 2000). Moreover, *delays and error reduction* move toward generating a positive reputation for the firm in the market (customer perspective) (Chand *et al.*, 2005). The outward relationships from the internal processes causal loop diagram are synthesised by reinforcements from *internal and environmental efficiency to profitability*, *organisational culture (oriented to learning and growth)* and *customer satisfaction*.

From the customer perspective of the causal loop diagram, two outward influences are directed to two different perspectives. Since a positive *corporate reputation* is mainly built on reinforcing relationships between a firm and customers, such favourable consideration increases with the number of *orders entered* from sales. Therefore, higher sales and reputation improve corporate *revenue growth* (Reefke and Trocchi, 2013). From the customer perspective, the causal loop diagram generates outward relationships that the reinforcements may summarise from *customer satisfaction* (the customer perspective) to profitability.

The financial causal loop diagram gives rise to three outward effects, two from the customer perspective and one from the internal processes' perspective. From a customer perspective, firms with a high capacity for investing obtain a double positive effect. Indeed, relevant *investment capacity* allows the firm to preserve independence from other business entities and be considered a leading player in the market, respectively increasing variables of *corporate reputation* and *brand awareness* (Hu *et al.*, 2017). Regarding the internal processes causal loop diagram, performing *R&D activities* enables the organisation to find new ways to optimise the production process to reduce waste (Aliakbari Nouri *et al.*, 2019). The outward relationships generated by the financial causal loop diagram may be condensed in the transitions from *profitability* to *internal and environmental efficiency* and *customer satisfaction*.

The systemic view of connections identified in the proposed loops and the extended strategy map offer relevant contributions to the OM literature from both a strategic and dynamic point of view. In other words, OM is not solely concentrated on transforming the input of raw material into goods and services – in a “siloe” way for which functions are vertical and disconnected from each other – but is at the centre of exchanges amongst other subsystems that should be considered when carrying out company activities efficiently and effectively (as is the aim of OM) (Adam, 1983, p. 366). This contrasts with the “sand cone” model (Ferdots and De Meyer, 1990), for which all four sustainable competitive advantages can be developed by following a particular sequence of strategic priorities. Whilst we recognise the empirical strength of the “sand cone” model, the proposed system dynamics relationships between the BSC perspectives discussed here adopt a less hierarchical view. At the same time, however, we cannot fully support the trade-off model of operational capabilities (Skinner, 1969), for which improving any one of the four basic manufacturing capabilities – quality, dependability, speed and cost – must necessarily be at the expense of one or more of the other three. The reciprocal relationships framed dynamically and systemically in this study underline how leveraging a variable in a BSC perspective (e.g. employee productivity) can differently impact other BSC perspectives (e.g. CRM effectiveness and revenue growth); that is, they do not always work as a trade-off.

## 6. Conclusions

Undertaking a systematic literature review of BSC articles published in OM journals, this study proposes dynamic relationships within and between the four BSC perspectives, when implemented and used in OM contexts, according to a system dynamics approach. We identify four loops, one for each BSC perspective, that describe the multiple dynamic relationships amongst the different performance drivers and outcome measures and their reciprocal influences (positive or negative) within each perspective. This, in turn, allows the creation of a dynamic strategy map for OM, which represents the relationships between the four BSC perspectives via interlinked loops rather than through an interlinked bottom-up hierarchy. This is the first study of its kind and theoretical and managerial implications can be drawn.

### 6.1 Contribution to scholarly knowledge

This study contributes to theory in several ways. First, our results provide the most representative performance drivers and outcome measures and their relationships within and between the four BSC perspectives in OM contexts. By doing so, our article identifies relationships amongst the indicators (performance drivers and outcome measures) and uncovers the dynamics and systemic interactions between them. It provides an advancement over more traditional, static views of performance measures and their interrelationships. In this vein, our literature-based findings (1) reinforce previous studies (e.g. [Oladimeji et al., 2021](#)), suggesting the need to move from a static to a dynamic view to help organisations better achieve their goals in the face of the renewed and ever-increasing contexts complexity and (2) gather empirical evidences to fill the gap – at least for the OM field – raised by [Nørreklit et al. \(2018\)](#) about the lack of empirical studies on causality between BSC perspectives.

Second, the provided causal loop diagrams and extended strategy map facilitate organisations in implementing a performance measurement system, making the connections between the different performance drivers and outcome measures explicit according to the system dynamics and addressing one of the main BSC criticisms, that is, its excessive focus on unidirectional linkages, simplistically exploited to linearly link measures across the four perspectives ([Akkermans and van Oorschot, 2005](#); [Barnabè, 2011](#)). Indeed, our findings demonstrate the existence of dynamic and sometimes reciprocal linkages, thus implying the possibility that these links will change over time, along with internal (e.g. organisational dimension) and external aspects (e.g. sector trends) of the firm.

Third, we are neither fully adhering to the “sand cone” model ([Ferdows and De Meyer, 1990](#)) of operational capabilities nor the trade-off model ([Skinner, 1969](#)). Our approach is that the different outcome measures and performance drivers within and between the four BSC perspectives in OM relate systemically, without a clearly defined hierarchy and not always balancing trade-off effects amongst indicators in the organisation. BSC indicators’ connections work in loops; three out of four are positive, with just one that can be defined as balancing (i.e. *customer satisfaction loop*). This means the indicators’ trade-offs cannot be identified by looking at indicators in dyadic terms. This is consistent with the system dynamics logic and can be the subject of future empirical investigations.

Lastly, the findings of this article provide relevant theoretical support to the viable system model (VSM) ([Beer, 1984](#)). In particular, [Beer \(1984, p. 18\)](#) highlights that subsystem “three”, representing the controls and structures ensuring synergy amongst operations, is difficult for organisational members to be recognised. The results of this work confirm how the BSC is a useful tool to control the cohesion of operations, supporting organisational viability. Integrating the system dynamics approach to the BSC perspectives provides valuable support to the systematic control of operations, improving the effectiveness of subsystem “three” of the VSM.



### 6.2 Implications for managers

Applying the proposed BSC dynamic strategy map for OM can pose challenges for practitioners, as its contribution primarily rests on a conceptual framework. The execution of models drawn from prior research is inherently complex, yet having a foundational framework can prove especially valuable in identifying the initial step for practical implementation. Whilst no universal “best way” exists, several optimal paths are conceivable, contingent on the organisation’s circumstances. These circumstances encompass internal facets such as the organisational life cycle stage, dimensions, culture, adopted strategies and external aspects like industry trends, historical context, technological advancements and societal shifts. However, the extended strategy map introduced in this study can serve operations managers by facilitating their comprehension of several key aspects: (1) the dynamic interrelationships within and between each perspective of the BSC; (2) the most relevant performance drivers and outcome measures within each perspective; (3) the reciprocal influences of different indicators within individual perspectives; and (4) the interconnections between the various perspectives themselves. Subsequently, the primary subsequent step for managers is to implement the provided loops and extended maps tailored to the unique operational context of their respective organisations.

Adapting the proposed strategy map to the specific context is imperative to ensure the performance management system’s efficacy. To achieve this, companies can follow a systematic procedure based on the performance measurement system literature (i.e. planning, action implementation and feedback and alignment) (Hristov *et al.*, 2021) including system dynamics application steps reported in subsection 2.3 (i.e. identifying of the problem/situation, identifying the variables and their relationship, modelling using system dynamics software, constructing a stock and flow diagram, verifying, validating and simulating the model and analysing the results) (Shaik and Dhir, 2021). This systematic procedure may be essentially performed through the resulting three steps: (1) *planning*, which includes pre-evaluation of the problem, objective identification (i.e. variables and their relationships), strategy map development (i.e. modelling) and simulation building (i.e. validating the model); (2) *action implementation* (i.e. simulating the model); (3) *feedback and alignment* (i.e. analysing the results). By systematically following these three steps, organisations can tailor the strategy map to their specific realities, enhancing its alignment with their unique goals, challenges and industry dynamics.

### 6.3 Limitations of the review and further research

Given the review nature of this work, the proposed strategy map for OM is not practically implemented, but only possible steps for its implementation are provided. Thus, scholars interested in OM and the BSC should enrich the proposed dynamic strategy map for OM by testing its practical validity and generalisability. In particular, future research could focus on the specific conditions under which the relationship between performance drivers and outcome measures is either positive or negative and determine if a trade-off model of operational capabilities can be verified under some circumstances. In addition, in line with the concept of “finality” (Nørreklit, 2000, p. 77), the multiple dynamic relationships within and between each BSC perspective is developed based on logic and not empirics. Further studies could use our results to empirically test these relationships, exploring how the presented strategy map affects the formation of operational capabilities in a co-evolutionary fashion (Cristofaro and Lovallo, 2022).

In this vein, and according to a system dynamics view, empirical analysis proving a statistical connection between the non-financial and financial indicators will be an important step in contributing to the BSC development. We suggest that BSC scholars build empirical models aimed at validating our results. For example, collecting data through a survey to quantify customer satisfaction on a Likert scale, thus creating a customer satisfaction index

and statistically testing the correlation between this index and one or more profitability indexes [e.g. return on assets (ROA) and return on investment (ROI)].

Moreover, the BSC implies a nomothetic approach; this denotes that BSC and its derivatives, including the proposed strategy map, need to be better suited to specific instances caused by competitive heterogeneity and characteristics of industrial sectors. Accordingly, future studies may start from our generic strategy map to explore particular situations through intensive study of a single case to validate proposed relationships. This focus can refine existing theories and redefine their boundaries (see Mode 2 - *Borrowing and Extending*; Zahra and Newey, 2009).

These issues encourage idiographic and longitudinal research, such as case studies to test the indicators' relationships over prolonged periods. In addition, based on the collected data, statistical analysis can provide in-depth insights into the model's validity. In particular, it potentially provides the evidence supporting specific relationships and the basis to overcome the assumption undermining Nørreklit's finality (see Mode 3 - *Transforming the Core*, in Zahra and Newey, 2009).

In addition, the strategy map based on the BSC does not cover the intricacies of investments and resources allocated to research and development that may be dispersed and not just captured by budgets for R&D. Investments in R&D may lead to prestige or many other benefits (Jaruzelski *et al.*, 2005). Future research could explore this phenomenon, extending, for example, the analysis of the R&D budget and R&D activity.

The other limits of this work relate to the systematic literature review protocol used. It may exclude some relevant literature (such as accounting) because it limits the data collection to articles published in selected OM journals. The results of our study can be replicated and extended beyond the OM field, selecting and analysing articles outside the operation discipline. Yet, as for all systematic literature reviews, our study is influenced by the heterogeneity of contexts (despite all of them dealing with OM), data collection methods and measurements.

In addition, the selection based on the ranking of journals should have been replaced with an assessment of the quality of evidence (see Dekkers *et al.*, 2022, p. 140). For instance, an adaptation of the Newcastle–Ottawa Scale (NOS) could be considered. Also, the grey literature (books, book chapters, etc.) is not explored, which could be relevant given that publication bias is likely in business and management studies (studies into failures or deficiencies of concepts, theories and so on are limitedly published). Another limitation is the assumption that the strategic map is an adequate reflection (model) of actual processes. Also, reference models, such as the breakthrough model in Dekkers (2017), could provide a backdrop for extensions and validation.

These limitations have been consciously considered from the beginning and through the analysis phase, so it is reasonable to believe that the probability that excluded research contained information that would critically alter the conclusions reached has been reduced. Future research may take a quantitative approach to study the proposed relationships and consider external actors' influence on firm operations. This would help see BSC implementation in OM as even more “systemic.”

#### Note

1. However, it was later, in 1971, that Forrester explicitly connected system dynamics with systems theories.

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**Table A1.**  
Previous reviews on  
the BSC

#	Title	Author(s)	Year	Journal	Main aim
1	Lives in the balance: An analysis of the balanced scorecard (BSC) in healthcare organizations	Gurd, B., Gao, T	2008	<i>International Journal of Productivity and Performance Management</i> , 57 (1), pp. 6–21	Review of the case studies published on BSC applications across the healthcare sector
2	What has been said, and what remains to be said, about the Balanced Scorecard?	Banchieri, L.C., Planas, F.C., Rebull, M.V.S.	2011	<i>Zbornik Radova Ekonomskog Fakulteta u Rijeci</i> , 29 (1), pp. 155–192	Review of the literature on the BSC made from 3 different dimensions: 1. Concept and evolution; 2. Practical use; and 3. Potential for implementation
3	Developments on balanced scorecard: A historical review	Abdullah, I., Umair, T., Naeem, B	2013	<i>World Applied Sciences Journal</i> , 21 (1), pp. 134–141	Historical review discussing and analysing the major studies conducted on the BSC
4	When one size does not fit all: A literature review on the modifications of the balanced scorecard	Lueg, R., E'Silva, A.L.C.	2013	<i>Problems and Perspectives in Management</i> , 11 (3), pp. 86–94	SLR exclusively focussed on those studies that deal with BSC empirical evidence
5	Performance measurement of organisations: A review of balanced scorecard technique	Umaval Kampagam, P.L., Suganthi, L	2013	<i>International Journal of Business Performance Management</i> , 14 (2), pp. 129–148	Review of the literature on the BSC in business and not-for-profit sectors
6	The balanced scorecard's missing link to compensation: A literature review and an agenda for future research	Albertsen, O.A., Lueg, R	2014	<i>Journal of Accounting and Organizational Change</i> , 10 (4), pp. 431–465	SLR exclusively focussed on those studies that deal with the BSC and compensation
7	Applications of the balanced scorecard for strategic management and performance measurement in the health sector	Behrouzi, F., Shaharoun, A.M., Ma'Arum, A	2014	<i>Australian Health Review</i> , 38 (2), pp. 208–217	Review of the last 10 years of research on the BSC in healthcare analysed according to the following 4 perspectives: 1. BSC generation; 2. BSC perspectives; 3. BSC indicators; and 4. Auxiliary tools
8	20 years of studies on the balanced scorecard: Trends, accomplishments, gaps and opportunities for future research	Hoque, Z	2014	<i>British Accounting Review</i> , 46 (1), pp. 33–59	SLR on the BSC accomplishments and trends
9	What do we really mean by "Balanced Scorecard"?	Perkins, M., Grey, A., Remmers, H	2014	<i>International Journal of Productivity and Performance Management</i> , 63 (2), pp. 148–169	A full review of the literature describing new iterations of the BSC was undertaken and these iterations were classified as minor developments or major generational evolution
10	Success factors in balanced scorecard implementations - A literature review	Lueg, R., Vu, L	2015	<i>Management Review</i> , 26 (4), pp. 306–327	SLR of the empirical literature on the implementation processes of the BSC

(continued)



#	Title	Author(s)	Year	Journal	Main aim
11	A review of balanced scorecard framework in higher education institution (HEIs)	Al-Hosaini, F.F., Sofian, S	2015b	<i>International Review of Management and Marketing</i> , 5 (1), pp. 26–35	Contextual analysis of more recent literature reviewed with respect to the BSC in the context of Higher Education Institutions
12	The sustainability balanced scorecard: A systematic review of architectures	Hansen, E.G., Schaltegger, S	2016	<i>Journal of Business Ethics</i> , 133 (2), pp. 193–221	SLR on sustainability and the BSC
13	The use and design of the BSC in the health care sector: A systematic literature review for Italy, Spain, and Portugal	M.B., Broccardo, L., Martins Pires A.M., Quesado, P., Guzman, B.A., Rodrigues L.L.	2017	<i>International Journal of Health Planning and Management</i> , 33 (1), pp. 6–30	Review of published papers concerning the BSC in the Southern European healthcare sector
14	Advantages and contributions in the balanced scorecard implementation	Fatima, T., Elbanna, S	2018	<i>Intangible Capital</i> , 14 (1), pp. 186–201	Bibliographic research of articles addressing advantages and critical success factors of the BSC
15	Balanced scorecard in the hospitality and tourism industry: Past, present and future		2020	<i>International Journal of Hospitality Management</i> , 91, art. no. 102656	A two-streamed literature search for articles on the BSC in general business, management and ethics and in the hospitality and tourism industry
16	Scoping review of balanced scorecards for use in healthcare settings: Development and implementation	Bohm, V., Lacaille, D., Spencer, N., Barber, C.E.H.	2021	<i>BMJ Open Quality</i>	SLR focussed on the development and/or implementation of a BSC in a healthcare setting
17	Sustainability balanced scorecard architecture and environmental performance outcomes: a systematic review	Jassem, S., Zakaria, Z., Che Azmi, A	2021	<i>International Journal of Productivity and Performance Management</i>	SLR on the BSC, with a focus on its sustainability architecture and environmental performance outcomes
18	Balanced scorecard: A systematic literature review and future research issues	Kumar, J., Prince, N., Baker H.K.	2021	<i>FIIB Business Review</i>	SLR on the BSC, with a strong focus on future research issues
19	Performance measurement tools for sustainable business: A systematic literature review on the sustainability balanced scorecard use	Mio, C., Costantini, A., Panfilo, S	2021	<i>Corporate Social Responsibility and Environmental Management</i>	SLR on sustainability BSC use

**Source(s):** Authors' work

Table A1.

**Table A2.**  
A sub-sample of the  
collected and analysed  
articles

Author(s) <i>a)</i>	Journal <i>b)</i>	Year <i>c)</i>	Type of article <i>d)</i>	Context <i>e)</i>	Data collection <i>f)</i>	Data analysis <i>g)</i>	Main findings <i>h)</i>
1 Akkermans and Van Oorschot	<i>Journal of the Operational Research Society</i>	2005	Explanatory case study	A business unit of Interpolis (one of the leading insurers in the Netherlands)	Workshop with management team members	Two-stage modelling process (qualitative causal loop diagramming followed by quantitative simulation), a BSC was developed	"This research illustrates how, through involvement of SD in this development process, management came to understand that seemingly contradictory goals such as customer satisfaction, employee satisfaction and employee productivity were, in fact, better seen as mutually reinforcing" (p. 931)
2 Aliakbari Nouri <i>et al</i>	<i>International Journal of Productivity and Performance Management</i>	2019	Empirical qualitative	15 experts of hospital supply chain	Interviews, questionnaires of Fuzzy Delphi Method	Interpretative structural modelling	"The presented general framework links the financial measures with the environmental and social measures" (p. 148)
3 Mehralian <i>et al</i>	<i>International Journal of Productivity and Performance Management</i>	2017	Empirical qualitative	30 largest pharmaceutical distribution companies in Iran	Survey questionnaires	Structural equation modelling	"TQM implementation can positively and significantly influence the BSC and its four perspectives" (p. 111)
4 Okongwu <i>et al</i>	<i>Journal of Manufacturing Technology Management</i>	2015	Empirical qualitative	450 French industrial firms	Survey questionnaires	Structural equation modelling	"There are many different paths (of strategic nature) that link SCMPs and other intangible assets to financial performance" (p. 678)

(continued)

Author(s) <i>a</i>	Journal <i>b</i>	Year <i>c</i>	Type of article <i>d</i>	Context <i>e</i>	Data collection <i>f</i>	Data analysis <i>g</i>	Main findings <i>h</i>
5 Reefke and Trocchi	<i>International Journal of Productivity and Performance Management</i>	2013	Conceptual	Literature concepts combination of performance measurement in SCs and sustainability with the BSC	–	–	“BSC is illustrated by practical examples in an attempt to demonstrate the feasibility and practical value of the conceptual approach” (p. 805)
6 Rodríguez-Rodríguez <i>et al</i>	<i>Computers in Industry</i>	2020	Empirical qualitative	Dynamic supply chain BSC-based methodology, ceramic supply chain (with the Original Equipment Manufacturer and two of its suppliers)	Literature review, PMS implemented with strategic objectives, associated action plans, and KPIs with historical data	PCA analysis, PLS2 regression	“Alignment of all the future efforts of a whole supply chain in order to reach one point on a plane, which is a combination of interrelated supply chain KPIs” (p. 1)
7 Sandström and Toivanen	<i>International Journal of Production Economics</i>	2002	Explanatory case study	Tulikivi Oyj and its subsidiaries form the Tulikivi Group, manufacture of soapstone fireplaces	Performance analysis system of the case company	Performance analysis based on the balanced scorecard concept and cost accounting techniques, theoretical part applied in the case company	“If the implementation of BSC is done properly, the idea of BSC is helpful in managing design engineers” (p. 79)

Source(s): Authors' work

Table A3.  
Journals' distribution

Field	AJG 2021	Journal Acronym	Extended name	Rank AJG 2021	Rank JQL 2021	No. papers
OPS&TECH		IJPPM	<i>International Journal of Productivity and Performance Management</i>	1	B	8
OPS&TECH		BAIJ	<i>Benchmarking: An International Journal</i>	1	B	5
OPS&TECH		PPC	<i>Production Planning and Control</i>	3		4
OPS&TECH		TQMBE	<i>Total Quality Management and Business Excellence</i>	2		3
OPS&TECH		IJPE	<i>International Journal of Production Economics</i>	3		3
OPS&TECH		JMTM	<i>Journal of Manufacturing Technology Management</i>	1	B	3
OPS&TECH		CI	<i>Computers in Industry</i>	3		2
OR&MANSCI		JORS	<i>Journal of the Operational Research Society</i>	3		2
OPS&TECH		JQME	<i>Journal of Quality in Maintenance Engineering</i>	1	B	2
OPS&TECH		JBL	<i>Journal of Business Logistics</i>	3		2
OR&MANSCI		EJOR	<i>European Journal of Operational Research</i>	4		1
OPS&TECH		TQMJ	<i>The TQM Journal</i>	1	B	1
OPS&TECH		IJOPM	<i>International Journal of Operations and Production Management</i>	4		1
OPS&TECH		IJPR	<i>International Journal of Production Research</i>	3		1
OPS&TECH		IJQRM	<i>International Journal of Quality and Reliability Management</i>	2		1
OPS&TECH		JIM	<i>Journal of Intelligent Manufacturing</i>	1	B	1
		TOTAL				40

Source(s): Authors' work

Authors <i>a)</i>	Main results associated with the focal SD relationship <i>b)</i>	Indicator 1 <i>i)</i>	Polarity <i>k)</i>	Indicator 2 <i>j)</i>	Direction <i>m)</i>	BSC perspective <i>n)</i>	Context <i>e)</i>	Notation within the related CLD <i>o)</i>	Strength of the relationship <i>p)</i>
Albuhisi and Abdallah (2018)	The authors underline that an organization culturally oriented to learning and growth usually works to involve employees in the ongoing training programmes. Reciprocally, quality and time dedicated to such training programmes are seen as significant contributions to the empowerment of workers' skills as well as their involvement in organisational culture oriented to learning and growth	Organizational culture oriented to learning and growth* (measure not specified)	+	Employee training and empowerment (measured as number of training programmes)	Bidirectional	Learning and growth (figure 3)	197 employees in managerial and non-managerial positions working in Jordanian pharmaceutical manufacturing companies	a	Moderate
Akkermans and van Oorschot (2006)	Developing a dynamic BSC by means of a case study, authors, within the learning and growth perspective, indicate how training and empowering employees' skills lead to increase their motivations at work	Employee training and empowerment (measure not specified)	+	Employee motivation (measure not specified)	Unidirectional		A business unit of Interpolis (one of the leading insurers in the Netherlands)	b	Moderate
Akkermans and van Oorschot (2006)	There are signalled lower absenteeism and less sick leaves to witness the reinforcing relationship between employee motivation and employee productivity	Employee motivation (measure not specified)	+	Employee productivity (measured as cases per employee per year)	Unidirectional		A business unit of Interpolis (one of the leading insurers in the Netherlands)	c	Strong
Quezada <i>et al.</i> (2014)	This paper draws a strategic map, founded on the BSC, that indicates a positive influence of employees' competencies and motivation on their productivity	Employee motivation (measure not specified)	+	Employee productivity (measure not specified)	Unidirectional		A small printing company		
Singh <i>et al.</i> (2018)	By means of a fuzzy-based method, it is evaluated that high motivations are required to enhance or maintain the productivity of employees to ultimately reinforce the loop of competitiveness	Employee motivation (measure not specified)	+	Employee productivity (measure not specified)	Unidirectional		A manufacturing SME		
Akkermans and van Oorschot (2005)	Basing on a less severity of the work pressure, authors' causal loop diagrams determine that higher productivity at work triggers greater employee satisfaction (of their work) to continue in the creation of a virtuous work environment	Employee productivity (measured as cases per employee per year)	+	Employee satisfaction and positive attitude* (measure not specified)	Unidirectional		A business unit of Interpolis (one of the leading insurers in the Netherlands)	d	Moderate

(continued)

**Table A4.** Dynamic relations within BSCs perspectives according to reviewed papers

Dynamic relationships within BSCs perspectives according to reviewed papers		SD relationship			BSC perspective		Notation within the related CLD (e)	Strength of the relationship (f)	
Authors (a)	Mean results associated with the focal SD relationship (b)	Indicator 1 (i)	Polarity (k)	Indicator 2 (j)	Direction (m)	BSC perspective (n)	Context (c)		
Akkermans and van Oorschot (2005)	Collaboration amongst employees is here reported as an essential element of the BSC learning and growth perspective. Indeed, such positive collaboration spirit (in the view of organisational objectives) is directly associated to a higher satisfaction of employees at work. In turn, employees' satisfaction contributes to develop, and especially to maintain, the cultural alignment between organizational objectives and learning and growth mind	Employee satisfaction and positive attitude* (measure not specified)	+	Organizational culture (oriented to learning and growth)* (measure not specified)	Bidirectional		A business unit of Interpolis (one of the leading insurers in the Netherlands)	e	Substantial
Decoene and Bruggeman (2006)	Amongst results of the paper, it is reported that employee satisfaction (measured by days of sick leave) may be improved, over the years, through a change in corporate culture with a positive return effect on employee satisfaction, even until organizational performance	Employee satisfaction and positive attitude* (measured by days of sick leave)	+	Organizational culture (oriented to learning and growth)* (measure not specified)	Bidirectional		A Belgian manufacturing division, of a Danish Company leading producer of polyolefin plastics, with about 670 employees		
Okongwu <i>et al.</i> (2015)	Within casual linkages amongst their BSC perspectives, authors indicate the reciprocal positive effect between information system efficiency and general efficiency. Indeed, a general internal efficiency keeps the organisational objectives clear, therefore information flows timely reach interested parties. Moreover, efficient information exchange ensures the synchronisation of parties' operations thus leading to reduction in inventory levels (with positive impact on reducing consumption namely on the environment) and costs	Internal and environmental efficiency (measure not specified)*	+	Information system efficiency (measure not specified)	Bidirectional	Internal processes (figure 4)	450 French industrial firms	a	Moderate
Alakbari Nouri <i>et al.</i> (2019)	This paper presents a sustainable service supply chain balanced framework, where the functionality of the information system is univocally related to improvement of communications (and then cooperation) across corporate operations	Information system efficiency (measure not specified)	+	Cross-operational communications (measure not specified)	Unidirectional		15 experts of hospital supply chain	b	Moderate
Andersen <i>et al.</i> (2004)	The authors, in depicting the strategic map associated to the BSC of a manufacturing company, associate the effectiveness of cross-operational communications to the effectiveness of those processes that involve more operational levels	Cross-operational communications (measure not specified)	+	Cross-operational integration (measure not specified)	Bidirectional		A company producing plastics sold internationally	c	Moderate

(continued)

Dynamic relationships within BSCs perspectives according to reviewed papers

Authors <i>a)</i>	Main results associated with the focal SD relationship <i>b)</i>	SD relationship Indicator 1 <i>i)</i>	Polarity <i>k)</i>	Indicator 2 <i>j)</i>	Direction <i>m)</i>	BSC perspective <i>n)</i>	Context <i>e)</i>	Notation within the related CLD <i>c)</i>	Strength of the relationship <i>p)</i>
<b>Andersen <i>et al.</i> (2004)</b>	The authors, in depicting the strategic map associated to the BSC of a manufacturing company, show how integration amongst operational levels is needed to stabilize those repetitive processes which ultimately lead to minimization of process errors (especially those due to difficulties in operational levels integration). Authors argue that changes in demand generate delays and errors in the service supply, as organisational routines are neither respected nor created as new. On the contrary, stable levels of demand would allow the organisation to get into routines hence decrease delays and errors on the chain. From these assumptions, the positive relationship between routines and errors reduction emerges.	Cross-operational integration (measure not specified)	+	Organizational routines (measure not specified)	Unidirectional	A company producing plastics sold internationally	d	Moderate	
<b>Supino <i>et al.</i> (2019)</b>	The article explains how process efficiency is strictly related to reduction of delays and errors on the chain. Indeed, errors compromise the quality of the products which could be returned and thus increasing waste and current production cycle time. As well, delays stretch delivery time involving larger costs (especially in fixed capital). Finally, it is clear the positive relationship between delays and errors reduction and internal and environmental efficiency.	Organizational routines (measure not specified)	+	Delays and errors reduction (measured as difference between due date-actual date and expected delivery-actual delivery)	Unidirectional	An organization launching e-commerce project	e	Moderate	
<b>Chand <i>et al.</i> (2006)</b>	The article explains how process efficiency is strictly related to reduction of delays and errors on the chain. Indeed, errors compromise the quality of the products which could be returned and thus increasing waste and current production cycle time. As well, delays stretch delivery time involving larger costs (especially in fixed capital). Finally, it is clear the positive relationship between delays and errors reduction and internal and environmental efficiency.	Delays and errors reduction (measured as difference between due date-actual date and expected delivery-actual delivery)	+	Internal and environmental efficiency* (measured by a combination of indicators as error/rework reduction, faster processing, consistent data, reduction in processing time, increase in throughput, reduced inventory-carrying cost, lower labour cost)	Bidirectional	A major international aircraft engine manufacturing and service organization	f	Substantial	
<b>Ferreira <i>et al.</i> (2016)</b>	This work draws a virtuous relation amongst supply chain operational, economic and environmental performances (with returns for customer satisfaction at the end), process quality as well as reduction rate in business waste	Delays and errors reduction (measured as difference between due date-actual date and expected delivery-actual delivery)	+	Internal and environmental efficiency* (measured by reduction in costs and reduction in environmental costs)	Bidirectional	Automotive company and corresponding first-tier suppliers			

(continued)

Table A4.

Dynamic relationships within BSCs perspectives according to reviewed papers

Authors <i>a)</i>	Mean results associated with the focal SD relationship <i>b)</i>	SD relationship	Indicator 1 <i>i)</i>	Polarity <i>k)</i>	Indicator 2 <i>j)</i>	Direction <i>m)</i>	BSC perspective <i>n)</i>	Context <i>o)</i>	Notation within the related CLD <i>o)</i>	Strength of the relationship <i>p)</i>
Brewer (2000)	The authors here demonstrate the positive relationship between delays and errors reduction on the chain and its waste reduction rate. Indeed, service quality requests to minimize delays and errors to have the lowest level of returned products, which get often turned into waste	Delays and errors reduction (measured as reduction in the differences between due date-actual date and expected delivery-actual delivery)	+	Production process waste reduction (measure not specified)	Unidirectional			Literature concepts combination of performance measurement in SCM with the BSC	$f_1$	Substantial
García-Buendía et al. (2022)	Within an integrated performance measurement framework to evaluate Lean Supply Chain Management (LSCM) performance, authors directly connect the detected products' reduction to the waste reduction.	Delays and errors reduction (measured as defect rate)	+	Production process waste reduction (measure not specified)	Unidirectional			Performance measurement framework based on empirical analysis with professionals	$f_1$	Substantial
Ferreira et al. (2016)	This work draws a virtuous loop amongst supply chain operational, economic and environmental performances with customer satisfaction, process quality as well as reduction rate in business waste reduction.	Production process waste reduction (measured as decrease in percentage of waste generated per thousand product units)	+	Internal and environmental efficiency* (measured by reduction in costs and reduction in environmental costs)	Unidirectional			Automotive company and corresponding first-tier suppliers	$f_2$	Substantial
Reefke and Trocchi (2013)	Authors state that supply chains are sustainable when concentrated on efficient business processes aimed to reduce consumption and waste, namely reporting a positive relation between production process waste reduction and efficiency	Production process waste reduction (measured as recycling rates)	+	Internal and environmental efficiency* (measured by a combination of indicators as: cost of fines, energy costs, operating expenditures)	Unidirectional			Literature concepts combination of performance measurement in SCs and sustainability with the BSC		Moderate
Barnabé (2011)	The author, within the final strategic map, highlights how satisfied customers (mostly due to Substantial product-service quality) play a crucial role in increasing the market reputation of that firm. Hence, it is clear the positive relationship between customer satisfaction and corporate reputation. On the other side, as customers choose that firm on others, it is also highlighted the reciprocal effect that a highly reputed firm has on the satisfaction of its customers	Customer satisfaction* (measure not specified)	+	Corporate reputation (measure not specified)	Bidirectional		Customer (figure 5)	A start-up service-based business	a	Moderate

(continued)



Authors <i>a)</i>	Main results associated with the focal SD relationship <i>b)</i>	Indicator 1 <i>i)</i>	Polarity <i>k)</i>	Indicator 2 <i>j)</i>	Direction <i>m)</i>	BSC perspective <i>n)</i>	Context <i>e)</i>	Notation within the related CLD <i>o)</i>	Strength of the relationship <i>p)</i>
<b>Goharshenasan et al. (2022)</b>	On the basis of the literature, author retrieves amongst others, the positive effect of customer satisfaction on customer retention	Customer satisfaction* (measure not specified)	+	Customer retention* (measured as variation in customer quantity over the times)	Unidirectional		Dynamic model for measurement supply chain performance based on a dynamic balanced scorecard	$a_1$	Strong
<b>Nielsen and Nielsen (2012)</b>	The parameterised BSC model, presented in the paper, directly connects the customer satisfaction, measured through the key indicator of perception of delivery time, to the customers' loyalty	Customer satisfaction* (measured by customer perceived delivery time)	+	Customer retention* (measure not specified)	Unidirectional		A large Swedish company in electrical engineering		
<b>Quezada et al. (2014)</b>	This paper draws a strategic map basing on the BSC structure. Such strategic map explicitly indicates that increasing customers' satisfaction involves increasing their loyalty and thus their retention rate	Customer satisfaction* (measure not specified)	+	Customer retention* (measure not specified)	Unidirectional		A small printing company		
<b>Nielsen and Nielsen (2012)</b>	The parameterised BSC model, presented in the paper, directly connects the customer loyalty obtained to the customers' recommendations, which build the reputation of the firm. Moreover, a higher corporate reputation invites customers to choose that firm again over the time. In this vein, it emerges how customer loyalty and corporate reputation are reciprocally positively related	Customer retention* (measure not specified)	+	Corporate reputation (measure not specified)	Bidirectional		A large Swedish company in electrical engineering	$a_2$	Moderate
<b>Reefke and Trocchi (2013)</b>	In the view of building a sustainable supply chain management model, authors show how the high firm reputation generates positive consequences in the customer perspective. In particular, a good corporate reputation helps the corporate itself to be more positively recognised as a market brand	Corporate reputation (measured by fraction of total sales invested for social projects per year and stakeholder involvement in decision making)	+	Brand awareness (measure not specified)	Bidirectional		Literature concepts combination of performance measurement in SCs and sustainability with the BSC	$b$	Moderate
<b>Hu et al. (2017)</b>	The strategic map, founded on the BSC perspectives of author's case study organisation, shows the direct effect of higher brand awareness on measures of sales orders	Brand awareness (measured by number of enquiries and market share)	+	Orders entry (measured as number of orders in a period)	Unidirectional		106 students in the role of CFOs of a new born mortgage brokerage company	$c$	Moderate

(continued)

Table A4.

Authors <i>a)</i>	SD relationship		Polarity <i>b)</i>	Indicator 1 <i>i)</i>	Indicator 2 <i>j)</i>	Direction <i>m)</i>	BSC perspective <i>n)</i>	Context <i>o)</i>	Notation within the related CLD <i>o)</i>	Strength of the relationship <i>p)</i>
	Mean results associated with the focal SD relationship <i>β)</i>	SD relationship								
<i>Okongwu et al. (2015)</i>	Within the intense debate on causes and effects of CRM adoption, authors state that it loses its effectiveness as orders increase. That is why the effect of orders entry, is negative on CRM effectiveness	Orders entry (measured as number of orders in a period)	-	CRM effectiveness (measure not specified)	Unidirectional			450 French industrial firms	d	Moderate
<i>Supino et al. (2019)</i>	In their comprehensive stock and flow diagram, authors report a larger market share as a direct consequence of more sales orders entered	Orders entry (measured as number of orders in a period)	+	Market share* (measured as percentage of a market segment served by the firm)	Unidirectional			An organization launching e-commerce project	d <sub>1</sub>	Substantial
<i>Chand et al. (2005)</i>	Amongst case study findings, authors report that increased sales orders, due to higher sales, directly impact market share	Orders entry (measure not specified)	+	Market share* (measure not specified)	Unidirectional			A major international aircraft engine manufacturing and service organization		
<i>Hu et al. (2017)</i>	The strategic map, founded on the BSC perspectives of author's case study organisation, shows that a certain firm market share may work as of the indexes for assessing firm brand awareness in that specific market. Here it is clearly indicated the positive effect of larger market share on brand awareness	Market share* (measured as percentage of a market segment served by the firm)	+	Brand awareness (measured by number of enquiries and market share)	Unidirectional			106 students in the role of CFOs of a new born mortgage brokerage company	d <sub>2</sub>	Moderate
<i>Okongwu et al. (2015)</i>	Despite authors conclude that CRM does not play any role on product-service quality, they state that effective CRM surely create strong and reciprocally satisfying relationship with customers. That is why the effect of CRM effectiveness is positive on Customer satisfaction	CRM effectiveness (measure not specified)	+	Customer satisfaction* (measure not specified)	Unidirectional			450 French industrial firms	e	Substantial
<i>Reefke and Trocchi (2013)</i>	Authors identify customer relationship as a key process for SC success, also due to its direct influence on customer satisfaction	CRM effectiveness (measure not specified)	+	Customer satisfaction* (measured by, i.e. lead times, number of complaints)	Unidirectional			Literature concepts combination of performance measurement in SCs and sustainability with the BSC		
<i>Hu et al. (2017)</i>	The strategic map, founded on the BSC perspectives, of author's case study organisation shows the direct effect of an outstanding profitability to the increase of the corporate EVA.	Profitability* (measured by profit after taxes and ROS)	+	EVA (measured as NOPAT/WACC*(TA/CL))	Unidirectional	Financial (figure 6)		106 students in the role of CFOs of a newborn mortgage brokerage company	a	Moderate

(continued)

Dynamic relationships within BSCs perspectives according to reviewed papers

Authors <i>a)</i>	Main results associated with the focal SD relationship <i>b)</i>	Indicator 1 <i>i)</i>	Polarity <i>k)</i>	Indicator 2 <i>j)</i>	Direction <i>m)</i>	BSC perspective <i>n)</i>	Context <i>l)</i>	Notation within the related CLD <i>o)</i>	Strength of the relationship <i>p)</i>
Nielsen and Nielsen (2012)	Authors develop a specific "Financial and R&D structure", where the direct influence of profit on the R&D budget is underlined as the latter strongly depends on the corporate's possibility of self-financing such activities	Profitability* (measured as net profit)	+	R&D budget (measured as amount foreseen to be spent in R&D activity)	Unidirectional		A large Swedish company in electrical engineering	$a_1$	Moderate
Nielsen and Nielsen (2012)	In the parametrised BSC model depicted by authors, it is univocally reported the positive effect of a higher R&D budget strictly used to improve R&D activity	R&D budget (measured as amount foreseen to be spent in R&D activity)	+	R&D activity (measure not specified)	Unidirectional		A large Swedish company in electrical engineering	$a_2$	Moderate
Aliaikbari Nouri et al. (2019)	In describing the mechanisms of their financial perspective, authors suggest that investments in R&D (i.e. use of resources and energy resources efficiency) can be effective in achieving process-costs efficiency	Production process-cost efficiency (measured as variable costs reduction)	+	Production process-cost efficiency (measured as variable costs reduction)	Unidirectional		15 experts of hospital supply chain	$a_3$	Moderate
Dror (2008)	With the objective of weighting the internal processes costs within the whole profitability, the author simply assumes that a lower cost per unit sold increases the contribution margin of that unit	Production process-cost efficiency (measured as variable costs reduction)	+	Residual contribution margin (measured as difference between revenues and variable costs)	Unidirectional		Frameworks combination of BSC and Quality Function Deployment (QFD)	$a_4$	Substantial
Lämsluoto and Järvenpää (2012)	The case company of this research is given to operate in a low margin industry and, as a consequence, it is supposed to massively increase its profitability for each decrease in production process costs. Therefore, authors are reaffirming the positive relationship between production process cost efficiency and contribution margin	Production process-cost efficiency (measured as variable costs reduction)	+	Residual contribution margin (measured as difference between revenues and variable costs)	Unidirectional		A Finnish food manufacturing company		
Hu et al. (2017)	Traditional report cockpit provides financial assumptions for BSC cockpit and, amongst others, it recalls how higher EVA contributes to rise the total corporate investment capacity	EVA (measured as NOPAT-WACC*(TA-CL))	+	Investment capacity (measure not specified)	Unidirectional		106 students in the role of CFOs of a new born mortgage brokerage company	$b$	Moderate
Hu et al. (2017)	Additional report cockpit provides financial assumptions for BSC cockpit and, amongst others, it states that higher capacity of investing increases the revenue growth of a firm (by means of investments in fixed assets which, under such conditions in a market economy, are simply assumed)	Investment capacity (measure not specified)	+	Revenue growth (measured as positive difference between current and past revenues)	Unidirectional		106 students in the role of CFOs of a new born mortgage brokerage company	$c$	Moderate

(continued)

Table A4.

Authors <i>a)</i>	SD relationship		Polarity <i>b)</i>	Indicator 2 <i>j)</i>	Direction <i>m)</i>	BSC perspective <i>n)</i>	Context <i>o)</i>	Notation within the related CLD <i>o)</i>	Strength of the relationship <i>p)</i>
	Mean results associated with the focal SD relationship <i>l)</i>	Indicator 1 <i>i)</i>							
<i>Supino et al. (2019)</i>	In the final diagram, authors connect strategic measures one another and, amongst others, it is highlighted how growing revenue involves higher coverage of fixed costs	Revenue growth (measured as positive difference between current and past revenues)	+	Fixed costs coverage (measured as the amount of fixed costs supported)	Unidirectional		An organization launching e-commerce project	d	Moderate
<i>Cunha Callado and Jack (2015)</i>	This research connects the four BSC perspectives by means of a survey of 121 agribusiness companies. Within the context of the financial perspective, the role of the fixed costs is confirmed as reducing the contribution margin available. On this assumption, it is clarified the positive relation of the fixed costs coverage on the residual contribution margin	Fixed costs coverage (measured as the amount of fixed costs supported)	+	Residual contribution margin (measured as difference between contribution margin and fixed costs)	Unidirectional		121 Brazilian agribusiness companies	e	Moderate
<i>Supino et al. (2019)</i>	Within a comprehensive stock and flow diagram, the authors directly connect the negative effect of fixed cost on the corporate ebit (one of the most used profitability indexes). Indeed, fixed costs wear out residual contribution margin to ultimately, lower firm profits. Then, positive relation between contribution margin and profitability is implicitly assumed	Residual contribution margin (measured as difference between contribution margin and fixed costs)	+	Profitability* (measure not specified)	Unidirectional		An organization launching e-commerce project	f	Substantial
<i>Tjader et al. (2014)</i>	Authors exploit a BSC-based analytic network process model to assess outsourcing decisions, in this view, it is attempted to reduce fixed costs to increase residual contribution margin to increase firm profits. Therefore, they recall the positive impact of a higher contribution margin left on corporate profitability	Residual contribution margin (measured as difference between contribution margin and fixed costs)	+	Profitability* (measured as RO)	Unidirectional		A Pittsburgh-based commercial building company with IT needs		

**Note(s):** Asterisk indicates the generic outcome measure (lag indicator), no asterisk indicates the specific performance driver (lead indicator)

**Source(s):** Authors' work

Dynamic relationships among BSCs perspectives according to reviewed papers					
Authors	Evidence	Relation			
		Indicator 1 (BSCs perspective)	Polarity	Indicator 2 (BSCs perspective)	
				Direction	
<b>Akkermans and van Oorschot (2005)</b>	This research sheds lights on the employee satisfaction (and all employee-related measures) as crucial element within strategic interdependencies of a case study company. In particular, employee satisfaction allows (among others) increasing the corporate reputation by means of internals' opinions towards touching new potential employees as well as customers	Employee satisfaction and positive attitude* (learning and growth perspective)	+	Corporate reputation (customer perspective)	Unidirectional
<b>Okongwu et al. (2015)</b>	Authors focus their attention on the role of CRM on firm financial and non-financial results. Anyway, at the base of an effective CRM, training the human capital that will manage the relationships with customers (with particular interest on managing complains) is considered essential. Hence, it clearly emerges the positive effect of employee training on CRM effectiveness	Employee training and empowerment (learning and growth perspective)	+	CRM effectiveness (customer perspective)	Unidirectional
<b>Chand et al. (2005)</b>	Authors perform a case study to finally draw a value chain illustration where the implementation of staff training systems directly reduces the delivery times and errors of the whole chain	Employee training and empowerment (learning and growth perspective)	+	Delays and errors reduction (internal processes perspective)<	Unidirectional
<b>Quezada et al. (2014)</b>	The strategy map presented in this paper indicates that a higher productivity of employees work helps to cover fixed costs. Lower fixed costs are due to both higher return of employees' paid hours and their ability to exploit corporate fixed tangible and intangible assets	Employee productivity (learning and growth perspective)	+	Fixed costs coverage (financial perspective)	Unidirectional

(continued)

**Table A5.** Dynamic relations among BSCs perspectives according to reviewed papers

## Dynamic relationships among BSCs perspectives according to reviewed papers

Authors	Evidence	Relation		Direction	
		Indicator 1 (BSCs perspective)	Polarity		Indicator 2 (BSCs perspective)
Akkermans and van Oorschot (2005)	Authors observe the positive effect of employee productivity on revenue growth through several channels of influence. Indeed, higher employees' productivity increases their daily number of sales orders. Next, higher employees' productivity allows to process more sales orders thus speed up the processing of new ones	Employee productivity (Learning and growth perspective)	+	Revenue growth (Financial perspective)	Unidirectional
Brewer (2000)	The author highlights that substandard products are wasted and reprocessed thus undermining production chain as well as tight time requirements for just-in-times deliveries. In general, wastes on the production process worsen workers' productivity	Production process waste reduction (internal processes perspective) <	+	Employee productivity (learning and growth perspective)	Unidirectional
Brewer (2000)	The author highlights that sub standards products are waste to then be reprocessed and adding costs to logistics processes (especially variable ones)	Production process waste reduction (internal processes perspective)	+	Production process-cost efficiency (internal processes perspective)	Unidirectional
Chand <i>et al.</i> (2005)	This contribution clarifies that process inefficiencies (mainly delays and errors in deliveries), as touching the customers, generate a negative reputation about the firm on the market. Vice versa, reducing such delays and errors improves corporate reputation	Delays and errors reduction (internal processes perspective)	+	Corporate reputation (customer perspective)	Unidirectional
Reefke and Trocchi (2013)	The strategy map, presented as conclusion of the paper, indicates the positive effect of firm reputation on the revenue growth (mainly exploiting the customer leverage)	Corporate reputation (customer perspective)	+	Revenue growth (financial perspective)	Unidirectional

*(continued)*

Dynamic relationships among BSCs perspectives according to reviewed papers

Authors	Evidence	Relation	Indicator 1 (BSCs perspective)	Polarity	Indicator 2 (BSCs perspective)	Direction
Hu <i>et al.</i> (2017)	The strategic map, founded on the BSC perspectives of authors' case study organisation, shows the direct effect of higher entrance of orders on the growth of revenues		Orders entry (customer perspective)	+	Revenue growth (financial perspective)	Unidirectional
Hu <i>et al.</i> (2017)	Traditional report cockpit provides financial assumptions and effects for BSC cockpit, and, among others, it recalls how a higher investment capacity allows the firm to enjoy a higher brand awareness by means of market consideration		Investment capacity (financial perspective)	+	Brand awareness (customer perspective)	Unidirectional
Hu <i>et al.</i> (2017)	Traditional report cockpit provides financial assumptions and effects for BSC cockpit and, among others, it recalls how an higher investment capacity allows the firm to enjoy an higher corporate reputation especially due to preservation of corporate independence		Investment capacity (Financial perspective)	+	Corporate reputation (Customer perspective)	Unidirectional
Aliakbari Nouri <i>et al.</i> (2019)	In describing the mechanisms of their financial perspective, authors suggest that R&D activities (i.e. use of resources and energy resources efficiency) head to a comprehensive production process efficiency primarily involving waste reduction. Therefore, the positive effect of R&D activity on production process waste reduction is defined		R&D activity (financial perspective)	+	Production process waste reduction (internal processes perspective)	Unidirectional

**Note(s):** \*In a systemic view, an indicator originally considered lag (i.e. employee satisfaction and positive attitude) takes on a lead function because it positively influences another lead indicator (i.e. corporate reputation)

**Source(s):** Authors' work

Table A5.