Digitalization of Global Container Shipping Lines

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Abstract Digital technologies are currently present in nearly all activities of companies including customer interaction, competition, operations, and innovations. The maritime industry is here no exception. The current challenges force companies that are market leaders in their industry to change their strategies.

This paper covers the digital transformation of global container shipping lines. The proposed approach to the development of a global container shipping line IT-architecture could provide substantial support during the implementation of strategic initiatives based on the suggested Balanced Scorecard reference models and the multi-level matrix by comparing and linking indicators and IT-architecture models. Proposed ideas of virtual testing and experiments for IT-architecture models development correspond to the modern approach to innovation and allow rapid technology deployment and the company strategic resources adjustment in accordance with a changing environment.

1 Introduction

Maritime transport plays a significant role in global trade, serving 62% of the world's cargo turnover (Vladimirov, 2016). According to UNCTAD/RMT/2020 "the international maritime turnover in 2019 was 11.076 million tons despite a negative economic outlook and trade trends which affected the growth of maritime trade. The growth of the world GDP slowed down to 2.5%, after 3.1% in 2018 and 1.1 percentage points below the historical average of 2001–2008. Most of the total cargo

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consisted of dry cargo (4.682 million tons) but containerized cargo is also of great importance" (UNCTAD/RMT/2020).

Currently, there are several trends influencing maritime transport and trade:

- Accelerated shift in globalization patterns and supply chain designs
- Risk-management and resilience-building of supply chains
- New customer spending and behavior
- Increased need for standards and interoperability
- Use of electronic documentation
- Digitalization and cybersecurity (UNCTAD/RMT/2020)

The impact of these trends has increased significantly in the face of the Corona pandemic, forcing industry participants to adjust their strategies to the current economic environment. Companies are actively incorporating digital technologies into their operations in an effort to improve operational efficiency, increase customer experience, retain old and gain new market shares. The influence of the above trends will continue and companies need to constantly monitor emerging innovations and disruptive technologies to implement the most successful ones for maintaining a good position in the market.

Furthermore, the global environment is also changing. Companies are in a stage of digital transformation, which has five strategic domains: customer relationship, competition, data, innovations, and value creation (Rogers, 2016). Digital technologies become an effective tool to gain and maintain market share and company profitability.

In this paper, the authors propose a coherent approach to the digitalization of global container shipping lines. This approach could provide a substantial support for company strategy implementation and IT-architecture modeling. Recent research shows a gap between strategy development and strategy implementation. Furthermore, there is a lack of understanding of the impact of the IT-architecture on a company's financial results and its long-term market position. The proposed Balanced Scorecard for the global container line digital transformation helps to evaluate the impact of large-scale changes in a company's IT- architecture on its financial, customer, and operational activities and to provide benchmarks for the implementation of new technologies.

Additionally, the authors introduce a multi-level matrix to compare and link indicators and IT-architecture models of global container shipping lines. Together with the IT-projects portfolio management system and the best-in-class technology platform, it enables a company to improve its IT-architecture modeling. The authors propose the use of virtual testing and experiments which makes it possible to adjust the implementation of IT- projects depending on the expected results.

2 Strategic Approach to the Global Container Shipping Line Digital Transformation

2.1 Status Quo and Current Challenges

Liner shipping was introduced at the beginning of the nineteenth century and after several decades the British shipowners created an association of liner carriers on the route from British ports to Indian ports and vice versa, named the United Kingdom Calcutta Conference. Since this time, liner shipping had begun a worldwide expansion (Rusinov et al., 2016).

The United Nations Conference of Plenipotentiaries on a Code of Conduct for Liner Conferences (1975) clarifies shipping lines as vessel-operating carriers and divides them into national and third-country shipping lines. "A group of two or more vessel-operating carriers which provides international liner services for the carriage of cargo on a particular route or routes within specified geographical limits and which has an agreement or arrangement with respect to the provision of liner services are clarified as liner conference (conference)" (UN Conference, 1975).

The container transportation development led to a new phase of liner transportation.

Containerization is one of the factors of economic globalization, closely related to the processes of globalization and fragmentation of world production. The major volume of container transportations is carried out by a small number of liner carriers, which are divided into global carriers that perform transportation between continents, and regional carriers that provide transportation on short routes.

In this paper, the authors consider the digitalization of the global container shipping line. For the clarification of this subject, we need to address the global strategy definition.

According to Griffin and Pustey, multinational corporations, in their quest to balance the goals of global efficiency, multinational flexibility, and global learning, tend to follow one of four strategic alternatives, one of them is the global strategy. The goal of the global corporation is to create goods and services that can meet the needs of all consumers in the global market which in turn is seen as one. The global strategy implies doing business in one format in any country of the world; a global company is thus not influenced by one domestic market (Griffin & Pustey, 2004).

Since the advent of liner shipping, a number of standards, laws, and acts have been developed for its regulation. Most part of these are international agreements and conventions, but the role of national legislation should not be underestimated. Nevertheless, global container shipping lines introduce the global strategy for balancing the influence of regulatory factors and to obtain flexibility and clarity in their decision-making.

The top ten container shipping lines ranked by deployed capacity and market share are presented in Fig. 1.

The division of the liner container transportation market can be done by geography:

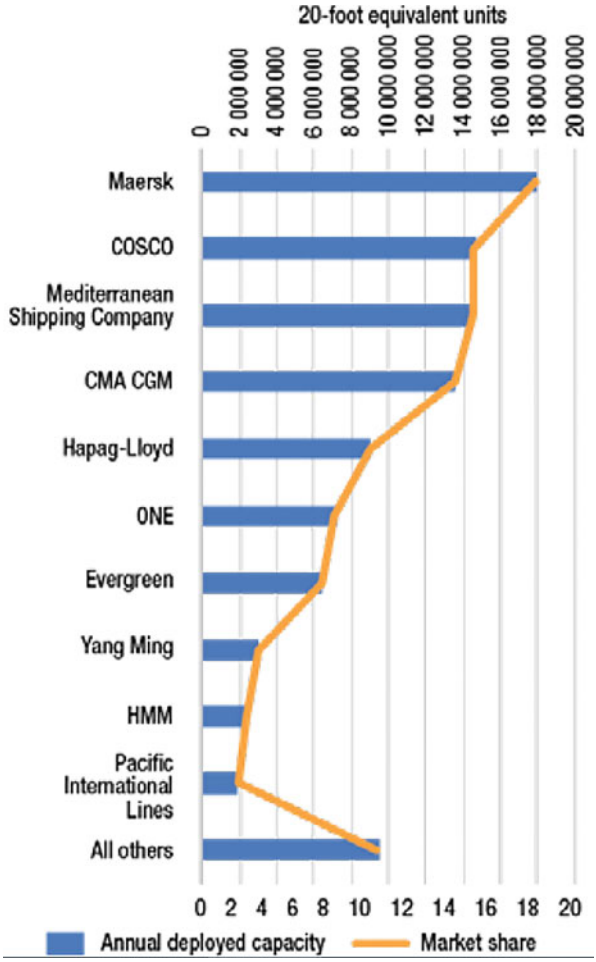

Fig. 1 Top 10 deep-sea container shipping lines, ranked by deployed capacity and market share, May 2020 (20-foot equivalent units and percentage) (UNCTAD/RMT/2020)

1. Intraregional
2. Mainlane East-West routes
3. Non-mainlane East-West routes
4. North-South routes
5. South-South routes (UNCTAD/RMT/2020)

In accordance with UNCTAD/RMT/2020, "Mainlane East–West containerized trade routes are Asia–Europe, the Trans-Pacific and the Transatlantic, which handle 39.1% of worldwide containerized trade flows. Trade on other routes, which involves greater participation from developing countries accounted for 60.9% of containerized trade. Together, intraregional trade, principally intra-Asian flows, and South–South trade represent over 39.9% of the total" (UNCTAD/RMT/2020). On the three major East–West container routes three global liner shipping alliances

dominate the capacity deployed (93% of the deployed capacity): 2M, Ocean Alliance and THE Alliance. Mediterranean Shipping Company and Maersk are members of 2M. The Ocean Alliance consists of three shipping lines: CMA CGM, China Cosco Shipping, and Evergreen. "THE" Alliance was established by Hapag-Lloyd, Yang Ming, and Ocean Network Express, which is also a joint venture of Nippon Yusen Kabushiki Kaisha, Mitsui Osaka Shosen Kaisha Lines, and Kawasaki Kisen Kaisha (UNCTAD/RMT/2018). Global alliances are a tool limiting the risks and costs of individual companies. Such alliances essentially seek to maximize the benefits of operational collaboration, while retaining the full rights of companies to pursue individual policies. The members of these alliances share where appropriate all operational assets—ships, containers, terminals, equipment, and other facilities.

"In an oversupplied market, consolidation is expected to continue. Two thirds of the container ship order book capacity is accounted for by ships of over 14,000 TEUs, and only large carriers and alliances are in a position to fill these mega ships" (UNCTAD/RMT/2018).

Currently, the industry is in its maturity stage, which is characterized by a considerably smaller growth; therefore, global container shipping lines need to change their strategy. Such transition is always accompanied by challenges for market leaders and opportunities for new players (Jensen, 2017).

The following key challenges are existing in liner container shipping (Jensen, 2017):

1. The structural overcapacity will continue to have a negative impact on the markets

The outsourcing of industrial production in the 1990s led to its relocation from Europe and the USA to Asia. Containerized cargoes were shipped then out of Asia to customers in developed countries; this led to a rapid growth of the containership fleet. The problem is that the expansion of capacity did not match overall global average demand, and in 25 years nominal fleet overcapacity has exceeded the number of containers available for transportation by 110%.

To capture the market share and to save container transportation costs, global container shipping lines have bought larger vessels. Thus, in 2011 new containerships with a capacity of 18,000 TEU were introduced. Such mega-vessels allow to reduce transportation costs per unit; therefore, container shipping lines will continue to order them (Fig. 2 Germanischer Lloyd).

However, not all companies will be able to afford this, only the largest eight to ten container lines will realistically even contemplate ordering more mega-vessels. This process will be followed by a high level of vessels scrapping. By 2025 it will become increasingly normal to scrap vessels in the size range of 6000–8000 TEU, and 5 years later it will become the 10,000 TEU vessels (Jensen, 2017).

2. Demography challenges, resulting in demand changes (Jensen, 2017)

For the container shipping business, an essential factor is where population growth is occurring. In the long term, shipping will face three problems:

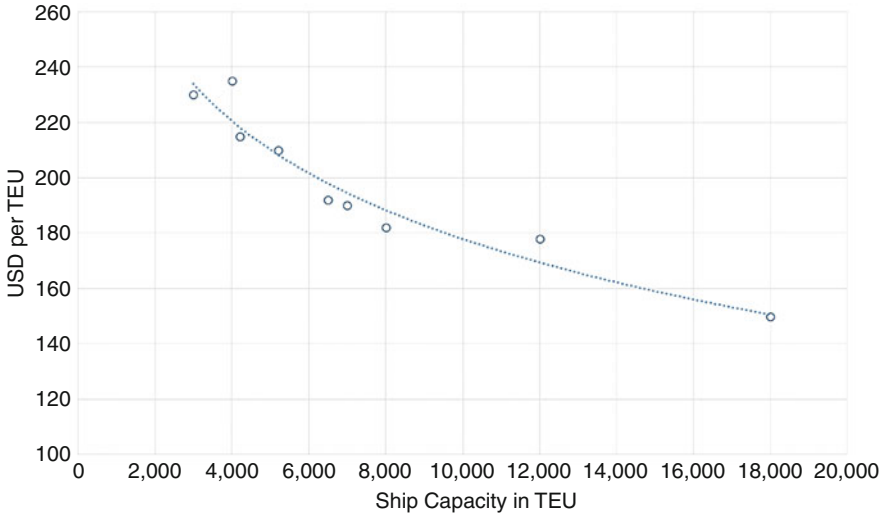

Fig. 2 Cost of 20-foot container transportation on the route Singapore-Rotterdam. Source: Germanischer Lloyd

- Increasing geographical dispersal of consumption
- Increasing geographical dispersal of manufacturing
- Demand structure change: shift from physical goods to services

3. Scientific and technical achievements.

In accordance with a recent UNCTAD report, "the spread of digital technologies in products and production over the past decade has led to a boom in trade and services, an increase of intangibles in global value chains and a very high increase of digital and tech firms among the largest multinational enterprises worldwide" (UNCTAD/WIR/2020). But, as argued in (UNCTAD/WIR/2017), "asset-light forms of international investments are just beginning to emerge and the full-scale digital transformation of the supply chains of firms that were not 'born digital' (especially in manufacturing) is only at the start. Digital Multinational Enterprises (MNEs) have grown partly in addition to, partly at the cost of, but mostly separate from traditional MNEs. And the digitalization of the supply chains of those traditional MNEs has in large part been bolted on to their existing international production configurations" (UNCTAD/WIR/2020).

New technologies influence all aspects of the global container shipping lines activity: customers, vendors, operations. Thus, in the UNCTAD "Review of Maritime Transport 2018" (UNCTAD/RMT/2018) experts mark out "technological advances in the shipping industry, such as autonomous ships, drones and various blockchain applications which hold considerable promise for the supply side of shipping. However, they also underline the uncertainty within the maritime industry regarding possible safety, security and cybersecurity incidents, as well as concerns about the negative effects on the jobs of seafarers" (UNCTAD/RMT/2018).

McKinsey & Company (Saxon & Stone, 2017) in their review of digital technologies influence on container shipping pay attention to the introduction of Big Data, the Internet of Things, Electronic Platforms, Advanced Analytics, and other technologies into the industry and recommend implementing the following to global container shipping lines:

1. Investments into digitalization
2. Consolidation
3. Integration (Saxon & Stone, 2017)

Furthermore, the Boston Consulting Group (BCG) points out the danger from "digital disruptors" and the need to introduce digital technologies to provide a transparent service. BCG defines seven directions of the digital transformation of the container shipping industry: Blockchain, E-platforms, Artificial Intelligence, Advanced Analytics, Internet of Things, Autonomous Vessels and Robotics Technologies, and Cybersecurity. The Boston Consulting Group analysts also note that the digital transformation agenda must be comprehensive, ranging from the strategic vision to the fundamental enablers (Egloff et al., 2018).

2.2 Methodology

Strategic alignment was introduced as a concept by Henderson and Venkatmaran (1999), this concept is also known as Business-IT alignment. Strategic alignment could be achieved by strategy formulation and strategy implementation processes which are interconnected and interact constantly.

Researchers have proposed a number of approaches to the alignment of the business and the IT architecture. Schelp and Stutz (2007) have adapted the Balanced Scorecard to use for IT measurements, Fritscher and Pigneur (2014) have proposed a model for the transformation between the Business Model Canvas and Archimate to improve Business-IT alignment. Other authors have proposed Enterprise Architecture (EA), a discipline for designing, planning, and implementing organizational change, for the strategic alignment improvement (Malta & Sousa, 2010) or have proposed a capabilities concept development for this purpose (Stirna et al. 2012; Teece & Pisano, 1994). The EA framework TOGAF (The Open Group Architecture Framework) standard has already introduced basic notions of capabilities and Capability based Planning.

Most of these approaches are extensions of established methods with a cross-domain approach but are focused on one or two domains. However, for the digital transformation of global container shipping lines, it is not enough to use only strategic model applications but you will also need to use technical approaches for the creation of the IT architecture. It is necessary to integrate a cross-disciplinary approach. The Enterprise Strategic Alignment Method (ESAM) can become such an approach (Aldea 2017).

ESAM is based on research results of the Twente University (Enschede, the Netherlands) and the BiZZdesign company (Enschede, the Netherlands) scientists

Phases	Disciplines			
	SM	CBP	EA	EPM
Visioning Process	+	–	–	–
Business Model	✓	✓	✓	–
Environmental analysis	✓	✓	✓	x
Strategic options	✓	✓	✓	✓
Strategic choices	✓	✓	✓	–
Strategy elaboration	+	–	–	–
Strategic measurements	✓	✓	✓	✓
Implementation design	–	✓	✓	x
Transformation planning	✓	✓	✓	✓
Implementation governance	–	–	✓	✓
Strategy evaluation	✓	✓	✓	✓

+ = provides input to another/multiple discipline(s)

– = receives input from another/multiple discipline(s)

✓ = provides and receives input to/from another/multiple discipline(s)

x = no interaction

Fig. 3 Cross-domain relationships (Aldea 2017)

group. This method represents a cross-disciplinary approach and consolidates existing approaches of such disciplines as Strategic Management, Capability Based Planning, Enterprise Architecture and Project Management. The ESAM cross-disciplinary interrelations scheme is provided in Fig. 3. The majority of ESAM phases have bilateral interrelations between the disciplines.

"ESAM have refined the strategic planning process into 11 phases: visioning process, business model, environmental analysis, strategic options, strategic choices, strategy elaborations, strategic measurements, implementation design, transformation planning, implementation governance, strategy evaluation (Fig. 4). Each of these phases contains at least one strategy model. ESAM presents a company activity business model as a subject domain, allowing to coordinate all strategic stages of the company transformation according to its changes" (Aldea 2017).

In this paper, the authors focus on the implementation of the company strategy, strategic measurements and metrics technique definition as well as the alignment of the business and the IT-enterprise architecture for the service-oriented enterprise architecture modeling. This allows the company to get a competitive advantage as a result of the implementation of the latest digital technologies.

For this purpose, in this paper strategic models like the Business Model Canvas (Osterwalder et al., 2010) and Capability Based Planning (Sandkuhl & Stirna, 2018;

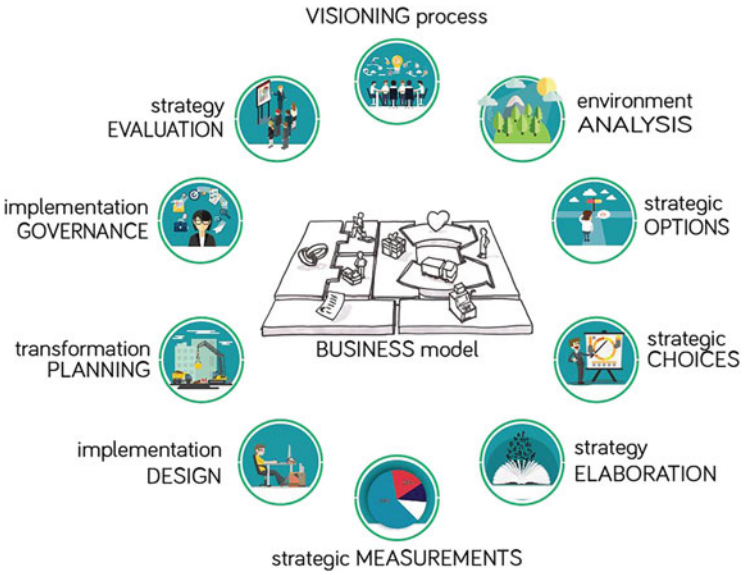

Fig. 4 The phases of the Enterprise Strategic Alignment Method (Aldea 2017)

Ulrich & Rosen, 2011) are used. The global container shipping line is considered as a logistics system in terms of the value-based Supply Chain Management concept (Brandenburg, 2013) and developed using the Balanced Scorecard (Kaplan & Norton, 2004) to allow an estimate of the digital transformation impact on the company long-term shareholder value. For global container shipping line Balanced Scorecard modeling the International Accounting Standards IAS (US-GAAP could also have been used), the strategic model Marketing Mix, the Supply Chain Operations Reference Model (SCOR), the BIMCO Shipping KPI's standard, the IMO standard, Capacity Management practice, and the international frameworks COBIT, ITIL as well as the enterprise architecture modeling language Archimate and the modeling tool Archi were used.

Reference models of the Balanced Scorecard strategic maps have been developed and ontologies have been proposed to be the basis for the global container shipping line "digital twin" creation.

The digital twin is a virtual model of a product, process, or system and represents complex multidisciplinary mathematical models with a high level of adequacy to real objects (Borovkov et al., 2019). This technology becomes an effective tool for high-tech product development and real-time enterprise or process management (Digital Twins Typologization, 2020).

A multi-level matrix of targets and resource constraints (real, financial, technological, and production) is an integral part of the digital twin development. Another part is Artificial Intelligence, which as a computer science discipline uses statistics

methods as well as machine learning and deep learning instruments (Borovkov & Ryabov, 2019).

For this paper, the multi-level matrix comparing and linking indicators and IT-architecture models of the global container shipping line was developed, and using of ontologies was proposed.

Thus, the authors suggest supplementing the ESAM method for global container shipping line digitalization with the following steps:

1. Balanced Scorecard development
2. Company digital twin modeling
3. IT-architecture modeling based on virtual testing and experiments

These steps will provide an opportunity to assess the results of the proposed changes in the company IT-architecture and make the necessary adjustments in the process of the strategy implementation.

3 Balanced Scorecard as the Basis for Global Container Shipping Line IT-Architecture Modeling

As was already mentioned above, digital technologies transform the global environment, affect customers, competitors, data use, innovations, and value creation. To meet the external environment challenges, companies need to have a flexible IT-architecture that can both support daily operations and form a solid foundation for strategic changes, including the use of the latest disruptive technologies.

The architectural concept approaches to the global container shipping line information systems were already formulated by the authors before:

1. "Digital business ecosystem architecture
2. New network communications and new storage and data processing technologies development
3. Strong inherent relationship between three main aspects, namely EA models, data from enterprise information systems and IoT devices, and advanced analytics" (Maydanova et al., 2019).

Researchers have investigated for the last decades how organizations can gain and maintain a competitive advantage in dynamic situations. This has led to the formulation of multiple theories, with a focus on resources and capabilities as a source for a competitive advantage.

To characterize the global container liner shipping business capabilities more precisely it is necessary to consider the company as a complex logistic network, which "represents the multilayered closed flow process: the upstream and downstream flows of products, services, finances, and information. Logistic networks, united by logistic agreements, represent a supply chain" (Brandenburg, 2013).

Therefore, "the global container shipping line digital transformation should provide effects on physical, logistical, financial and service supply chain flows. During the company's digital transformation, it is necessary to analyze technical capabilities and their influence on the company's strategy implementation, for this purpose the value-based management theory could be used" (Maydanova et al., 2019).

"Value-based management (VBM) is a creation of an activity results assessment system on the company value basis and aligning management tools in accordance with this integrated indicator. Based on the comprehension of Modigliani and Miller (1958), the financial value of a firm is determined by the present value of its future cash flows. There is a direct interrelation between the company value and its business model as used business model determines company future cash flows" (Brandenburg, 2013).

The concept of value-based management (VBM) is linked to shareholder value. "Shareholder value and debt are seen as complementary portions of the total economic value of a company or business unit. The maximization of shareholder value is perceived as the primary objective of a company, and hence VBM stipulates that all parts of a company are managed in such a way that the equity value of this entity is increased, i.e. shareholder value is added. Being obliged to this objective by defined targets and effective compensation packages, management can apply decision making in financing, investing and operating in order to improve the operating profit, increase the capital turnover and reduce the effective tax rate. These value drivers in turn have an impact on the valuation components cash flow, discount rate and debt and ultimately influence the shareholder value of a company" (Brandenburg, 2013).

"As the global container shipping lines are a logistic network and international supply chain basis, it is necessary to consider company management as the value-based Supply Chain Management" (Maydanova et al., 2019).

The conceptual design of a framework for value-based SCM comprehended as production process, influences company value by four financial drivers: sales, cost, working capital, and fixed assets. The indicators system for global container shipping line digital transformation needs to ensure control by the influencing company on the value by above-stated factors. Investment and financial decisions quality need to be supervised as well (Fig. 5).

The Balanced Scorecard suggested by the authors (Maydanova et al., 2019) "is a logical extension of the value-based Supply Chain Management Framework."

"The financial perspective represents a set of operating, financial, and investment activity goals. The strategic objectives of a company financial position should also be defined. The digital transformation strategic objectives achievement will allow to increase the company long-term shareholder value" (Maydanova et al., 2019). Strategic objectives from the customer, the internal processes, and organizational capacity perspectives are specified by a breakdown of the financial perspective goals into its drivers.

The company's long-term shareholder value is determined by the cost of capital, the tax rate, and the company value growth duration as well as logistic network

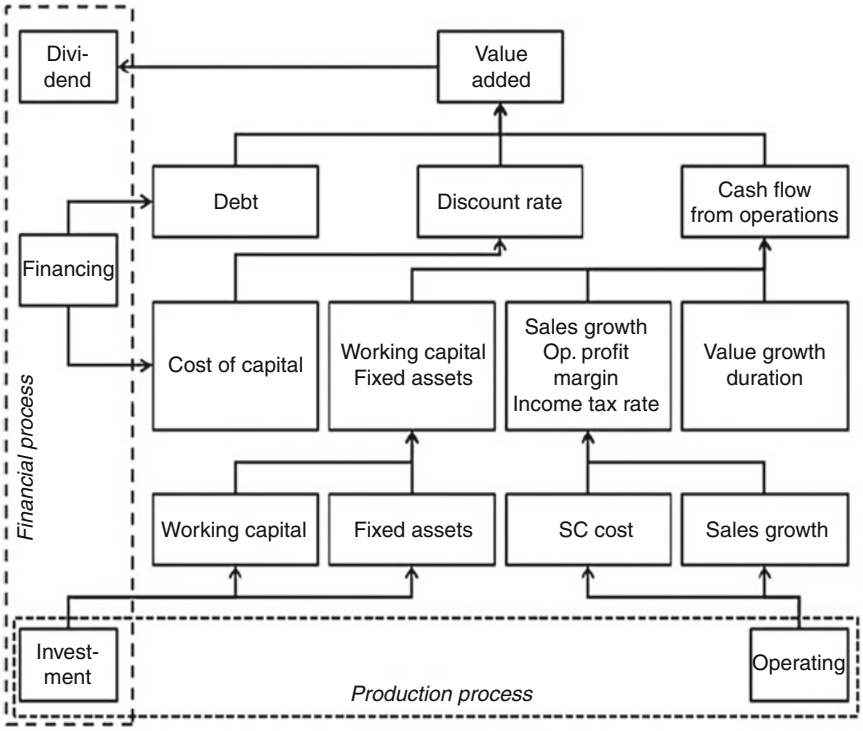

Fig. 5 Conceptual framework for value- based SCM (Brandenburg, 2013)

operational process management drivers like sales growth, working capital, supply chain operational cost, and assets efficiency. These items allow formulating a digital transformation strategy. "Achieving these objectives will increase the long-term shareholder value of global container shipping lines by:

1. increases in market share;
2. new products and services sales;
3. sales to new customers;
4. value co-creation;
5. maximization of working capital effectiveness;
6. reduction of service maintenance costs;
7. maximization of assets utilization effectiveness" (Maydanova et al., 2019).

Additionally, the company's financial activity strategic objectives are specified (Maydanova et al., 2019). Financial perspective strategic indicators could be set in accordance with the DuPont Formula theory (Fig. 6).

In the marketing environment, there are a number of critical business transformations, all with significant implications for supply chain management. "They could be characterized as follows: a shift of marketing strategy from the supplier to customer; from the push strategy to the pull strategy; from inventory to information;

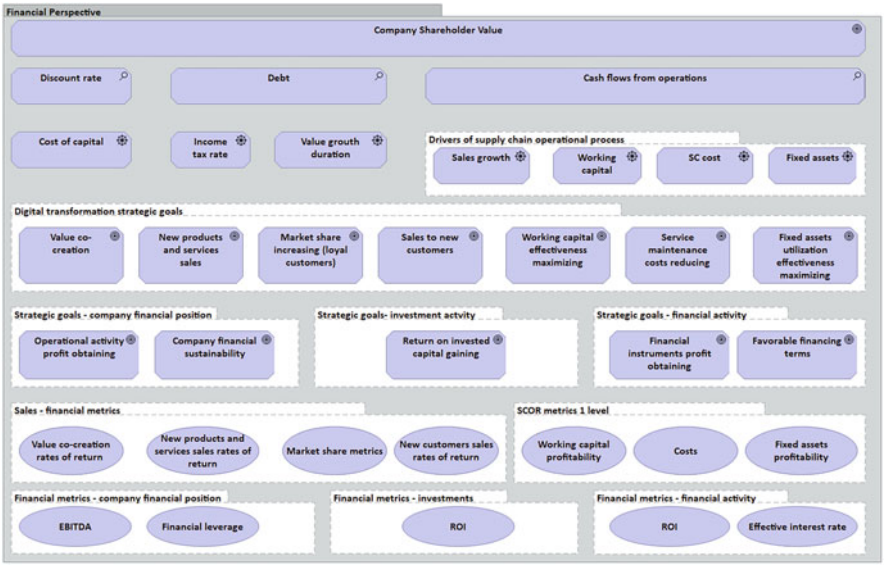

Fig. 6 Financial Perspective strategic map (Maydanova et al., 2019)

from transactions to relationships; from 'trucks and warehouses' to end-to-end pipeline management; from functions to processes; from the stand-alone competition to network rivalry" (Christopher, 2005).

The customer perspective drivers reflect "the processes happening in supply chain management and the factors influencing their changes:

- real demand information obtaining;
- customer relations management;
- flexibility and efficiency for customers;
- delivery process end-to-end integrated management;
- resources flexibility;
- focus on the processes creating value for clients;
- effective use of resources and competences of partners;
- use of digital marketing tools".

"For the customer perspective strategic objectives definition, it is necessary to use a strategic model marketing mix and strategic and digital marketing tools" (Fig. 7) (Maydanova et al., 2019).

The customer perspective strategic objectives are as follows:

1. Obtaining information about actual demand in a timely manner
2. Partners competences and use of resources
3. Lead generation
4. Increase of the customer service level
5. Omnichannel sales

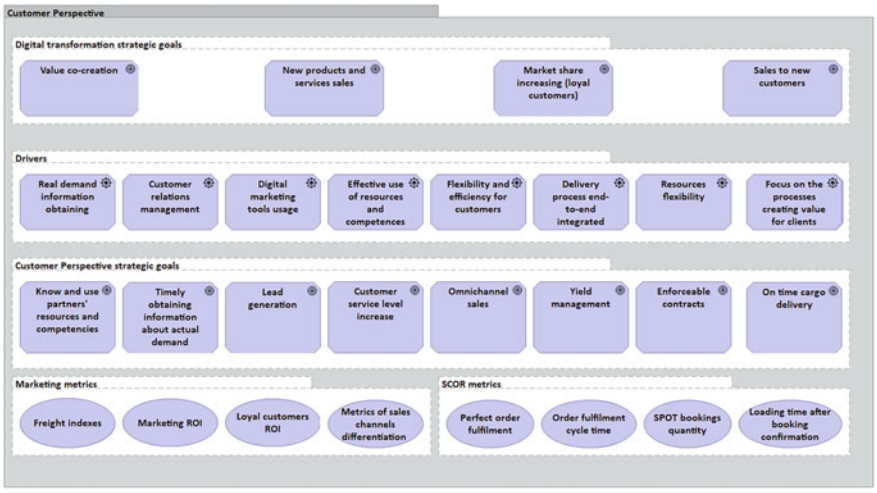

Fig. 7 Customer Perspective strategic map (Maydanova et al., 2019)

6. Yield management
7. Enforceable contracts
8. On-time cargo delivery

The customer perspective strategic indicators could be set with the metrics, used in strategic and digital marketing (Fig. 8).

As a basis of the internal process perspective in this paper, the Supply Chain Operations Reference Model was used. "This model is built around six major processes: Plan—Source—Make—Deliver—Return—Enable and covers the key supply chain activities from identifying the customer demand all the way through to delivering the product and collecting the money. The aim of SCOR is to provide a standard way to measure the supply chain performance and to use common metrics to benchmark against other organizations" (Christopher, 2005).

Internal process drivers in accordance with SCOR are defined as performance, processes, practices, and people. Strategic goals are determined as strategic characteristics of supply chain performance: reliability, responsiveness, agility, costs, and asset management efficiency. SCOR provides an opportunity to analyze supply chain processes and to correlate the internal process perspective indicators with other Balanced Scorecard indicators; therefore, the SCOR model becomes extremely an effective tool during the company's digital transformation. "SCOR does not attempt to prescribe how an organization should conduct its business or tailor its systems/information flow. Every organization that implements supply chain improvements using SCOR will need to extend the model, using industry, organization, and/or location-specific processes, systems, and practices" (APICS, 2017).

The global container shipping line network is deployed based on the major vessels on deep-sea routes connecting hubs as well as major other ports. In addition to this, there are also localized niche and feeder services. Established cargo flows as

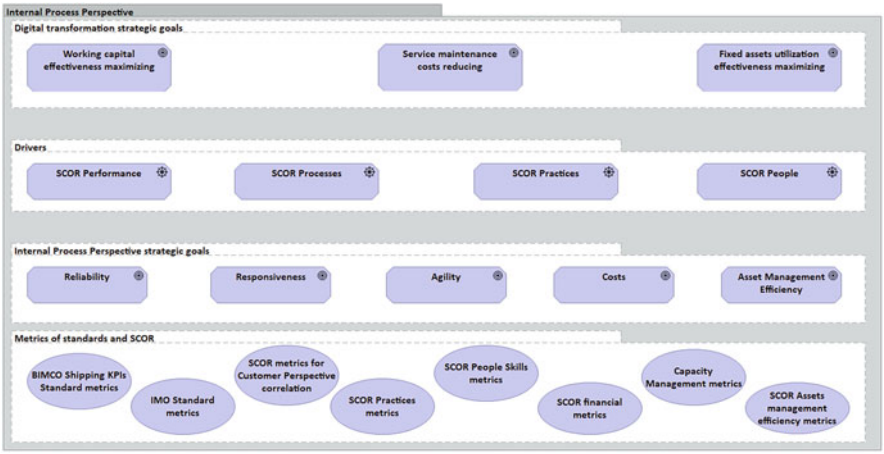

Fig. 8 Internal Process strategic map (Maydanova et al., 2019)

well as effective assets management have a high influence on global container shipping line processes.

The system of key performance indicators for the commercial fleet operating activity analysis and benchmarking was developed by the Baltic and International Maritime Council (BIMCO)—the international sea trade transportations industry association. This system was organized as a standard, named BIMCO Shipping KPI Standard.

A considerable influence on a vessel efficiency indicators has the following special vessel characteristics such as loading capacity, speed, and consumed fuel. However, the modeling of the vessel calls network has the most significant effect on commercial fleet efficiency.

The commercial fleet utilization in the container transport is called liner ship fleet planning and consists of three main objectives:

1. Optimum vessels size and fleet structure
2. Optimum fleet operation mode
3. Optimum vessel calls network

Capacity management is an important part of supply chain management, allowing the companies to be competitive in the market and to fulfill customer requirements in the most flexible way with minimum expenses.

The container liner shipping industry possesses a considerable impact on the environment due to its global activity. Compliance with environmental protection standards is an essential indicator of global container shipping line activity. Universal safety and environmental efficiency standards are defined by the International Maritime Organization (IMO). Additionally, safety and environmental efficiency standards can be established by national laws.

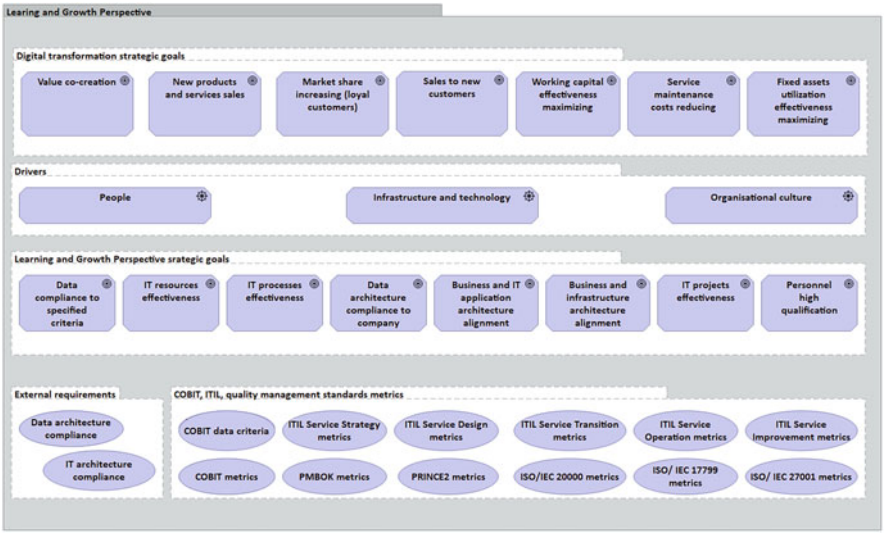

Fig. 9 Learning and Growth Perspective strategic map

Internal Process Perspective indicators need to be amended with the BIMCO Shipping KPI Standard, the IMO standard, and capacity management metrics.

Learning and growth perspective drivers are people, infrastructure and technology, and culture (Fig. 9).

The SCOR model allows the "correlating of performance, processes, practices indicators with the supply chain personnel skills. Additionally, the BIMCO Shipping KPIs Standard establishes requirements for human resource management to ensure safe and efficient operations of the ships" (Maydanova et al., 2019).

During the global container shipping line digital transformation, IT-architecture strategic indicators, initiatives and problems definition, and IT-architecture changes control by expert organizational structure are needed.

"The Open Group Architecture Framework (TOGAF) originated as a generic framework and methodology for development of technical architectures but evolved into an enterprise architecture framework and method could be tool for enterprise architecture design" (Ilin et al., 2017). "The Architecture Development Method (ADM), which is considered the TOGAF core, and consists of a stepwise cyclic approach for the development of the overall enterprise architecture" (Lankhorst, 2017), will provide the necessary support for the global container shipping line IT-architecture modeling.

To set strategic indicators for company EA governance it is relevant to use COBIT and ITIL frameworks (Maydanova et al., 2019).

The learning and growth perspective strategic goals of global container shipping lines have to provide to a company digital transformation strategic objectives achievement and could be formulated as follows:

1. Data compliance to specified criteria
2. IT resources effectiveness
3. IT processes effectiveness
4. Data architecture compliance to company strategic goals
5. Business and IT application architecture alignment
6. Business and infrastructure architecture alignment
7. IT projects effectiveness
8. Personnel high qualification

Learning and growth perspective strategic indicators have to provide data architecture and IT architecture compliance both legislation requirements as well as requirements of the standards and frameworks.

4 Global Container Shipping Line Digital Transformation and Enterprise Architecture Modeling

The software lifecycle management standards and methodologies place great importance on metrics collection and management. IT-project metrics are indicators that reflect their individual characteristics, measurement, or combination of measurements performed within the IT-project or the IT-process. The IT-project management problems could be defined as follows: the ambiguity and complexity of selecting indicators for tracking; the difficulty in interpreting the results and the use of the obtained data for the IT-project development.

The collection of the metrics itself is practically useless without a thoughtful implementation—it is necessary to correctly interpret the results, to identify IT-project risks, to determine corrective actions, and to forecast metrics.

The authors have suggested the use of an ontology to standardize the knowledge collection and presentation approach (Maydanova et al., 2019). Ontology (in computer science) is an attempt to detail and comprehensively formalize a certain field of knowledge by using a conceptual scheme. One of the main advantages of using an ontology is the ability to combine the information obtained from various information sources. The use of ontologies will create a unified knowledge database that contains information about IT-projects and in particular metrics and experience with their use.

For the global container shipping line digital transformation control, the following ontologies are proposed:

1. The Balanced Scorecard metrics ontology. The main properties of metrics will be a list of primary indicators, recommended targets and critical thresholds and a recommended frequency of reading. This ontology should be linked to the IT-project database through the metrics usage precedent database.
2. The risks and constraints ontology: categories of risks and constraints—technical, external, risks and constraints of the environment and project management, risks

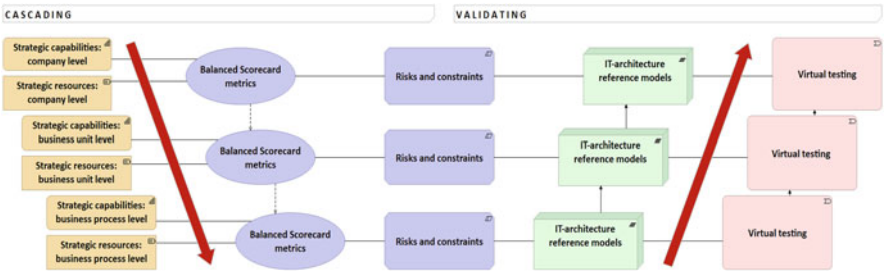

Fig. 10 Multi-level matrix comparing and linking indicators and IT-architecture models of the global container shipping line (Maydanova & Ilin, 2019)

and limitations of testing. The risks and constraints ontology through the history of risks and constraints database should be linked to the IT-project database.

3. Forecasting methods ontology, associated with the IT-project database through the forecasting precedents database.
4. The IT-architecture reference models ontology, related to the IT-project database, as well as to the risks and constraints ontology through the history of risks and constraints database.

Digital technologies have an impact on the innovation process, which is based on rapid experimentation and continuous learning. Unlike the old approach, which focused primarily on the finished product, the new approach focuses on identifying the right problem and then developing, testing, and learning on the many possible solutions. This approach focuses on developing minimally viable prototypes and iterating them repeatedly—before, during, and even after launch. Each assumption is tested and decisions are made. Because digital technologies make it easier and faster than ever to test ideas, this new approach to innovation is needed to get new ideas to market faster with less cost, less risk, and greater organizational efficiency cost and more organizational learning.

The proposed ontologies used are based on the developed reference models of the Balanced Scorecard strategic maps that can become a basis for the creation of a global container shipping line "digital twin". A digital twin is a dynamic data-driven software model for representing and analyzing the organization's activities and its current business model. The digital twin can be used to respond to changes in the external and internal business environment. Such an approach will allow the company an IT-architecture modeling, based on virtual experiments and will increase productivity and efficiency of strategic changes implementation.

To create the company's digital twin, it is necessary to correlate a large number of strategic indicators, risks and constraints, forecasting precedents, and IT-architecture reference models. Figure 10 represents a multi-level matrix comparing and linking indicators and IT-architecture models of the global container shipping line as a whole and its business units and business processes.

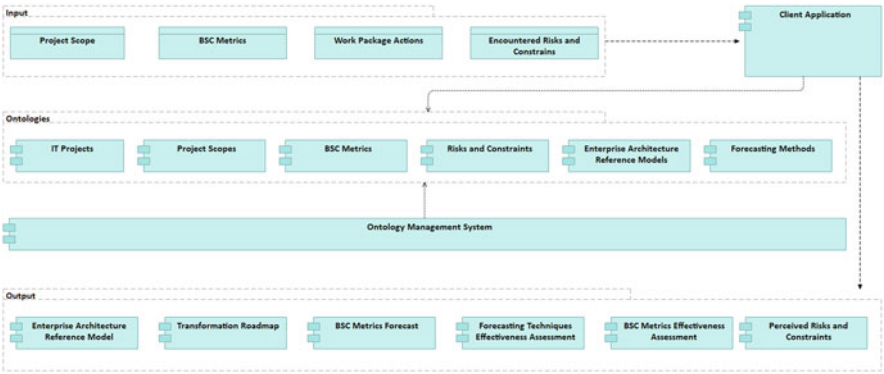

Fig. 11 IT-projects portfolio management system

The strategic indicators cascading takes place from the top down, from the company level to the level of the business processes, since the global container shipping line implements a unified strategy for all business units. The Balanced Scorecard metrics are correlated with risks and constraints, as well as with the IT-architecture reference models. At each level, there can be several IT-architecture reference models depending on the technologies proposed for implementation.

The multi-level matrix should provide the ability to not only track the metrics, risks and constraints, and IT-architecture models mutual impact, but also allow to make necessary changes and clarifications as soon as possible, to carry out operational management of the company digital transformation. For this purpose, the IT-architecture model is validated, from the pilot project of business process level to the strategic changes of the company IT-architecture. The validation occurs as a result of virtual testing using various forecasting methods. After the pilot project launching the ontologies of strategic indicators, risks and constraints, IT-architecture models and forecasting methods should be refined and supplemented by comparing prognosis and actual indicators.

The digital transformation of the global container shipping line requires a number of pilot IT-projects implementation but companies frequently are limited with tools of its management and evaluation (Ilin et al., 2014). For the purpose of IT-projects portfolio management, the authors have proposed to use an intellectual system, represented in Fig. 11.

The third platform for the modeling of the global container shipping line digital transformation should represent best-in-class technologies, available at the moment for the company's development. Representation means benchmarking of digital technologies implementation by industry leaders. Such technologies could be used by the company for its digital transformation but could be refused due to risks and constraints in regard to the implementation but awareness of the performance of these technologies is crucial. Such a knowledge base cannot be created overnight,

consistent and ongoing work is needed to monitor and evaluate emerging technologies. For this purpose, research and testing of technologies should be carried out and virtual experiments can also be conducted to obtain benchmarks for the use of the latest technology. This work should be done either by a special department or by an expert organization specializing on technologies in maritime transport.

The proposed approach is an effective tool for planning, implementing, and monitoring of strategic changes in the context of the global container shipping line digital transformation. It allows avoiding errors and inefficient management as it will enable the company to analyze the impact of a significant number of indicators to achieve strategic goals, as well as to adjust the strategy due to changes in external and internal capabilities and resources.

5 Conclusion

The maritime transport industry is currently under the influence of trends related to changes in the structure and volume of demand, excess capacity, and the digital transformation of its customers and partners. Industry participants need to adjust their strategies, improve operational efficiency, create new channels to promote their services, improve relationships with customers, to create new value propositions. The consolidation processes currently underway in the industry are leading to the consolidation of key players which in turn are making efforts to build business ecosystems and digital transformation of operations. The implementation of new technologies is now widespread in the maritime industry but a rapidly changing environment requires changes of the company IT-architecture on the sustainable manner and demands integrated approach.

The Enterprise Strategic Alignment Method provides such an approach, its application for the digital transformation of global container shipping lines will allow a transition from a company strategy to practical actions, company business processes and an IT—architecture alignment, development of company activity strategic indicators, and performance control. As proposed in this paper the Balanced Scorecard provides an opportunity to track the impact of changes in the global container shipping line IT-architecture and its activities in terms of financial, customer, operational perspectives, and learning and growth perspective. To align the company's business and IT-architecture, it is relevant to use ontologies of strategic indicators, risks and constraints, forecasting methods, and the company's IT-architecture reference models.

The proposed multi-level matrix comparing and linking indicators and IT-architecture models allows creating a company "digital twin" that will ensure information support and tracking the impact of IT-architecture changes on the company's performance. The global company digital transformation involves the implementation of multiple pilot projects, the results of which must be monitored to obtain the necessary information for the prediction and modeling of IT- architecture. The proposed IT-projects portfolio management system makes it possible to monitor

processes and results of pilot projects implementation and making the necessary adjustments to the indicators to build a company "digital twin". Virtual testing and experiments based on the BSC metrics, risks and constraints, pilot projects results implementation and the knowledge base of the best-in-class technologies will allow modeling of the changes in the IT-architecture of a global container shipping line, which are necessary to achieve strategic results and adjust the strategy in accordance with changes in the business environment.

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