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

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Abstract. Companies in the container liner shipping industry actively introduce digital technologies, which have a significant impact on all business aspects of a company. New technologies could become drivers for new business models. The digital transformation requires changes of company IT-architectures, cultures, and organizational frameworks. Monitoring and planning digital transformation processes require a method that allows evaluating the changes in the company's IT-architecture in the context of their compliance with the company's strategic goals. The Balanced Scorecard normally is used as a tool for the strategy implementation assessment. This article proposes the Balanced Scorecard application to measure and plan IT-architecture changes, using it as the basis for the company's digital twin. This tool could provide substantial support for global container shipping line digital transformation planning and monitoring. For the purpose of current study, the authors use the multi-level matrix comparing and linking indicators and IT-architecture models of the global container shipping line.

Keywords: Digital twin · Container shipping line · Enterprise architecture · Balanced scorecard · Digital transformation

1 Introduction

As the authors of this paper described before, "analysts define seven trends of digital transformation, which are capable to change the container liner shipping industry: blockchain, electronic platforms, Internet of things, predictive analytics, artificial intelligence, autonomous vessels and robotics, and cyber security"[1].

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In accordance with [2–4], the shipping industry invests heavily in technologies that can transform established business models. Such new technologies relate to ship operations, as well as strategic decisions and day-to-day operations, and also issues like automated navigation systems, cargo tracking systems and digital platforms that facilitate operations, as well as trade and data exchange. This can help reduce costs, facilitate interaction between different actors and raise the supply chain served by maritime transport to a new quality level.

The authors proposed an architectural approach concept to the information systems formulation as well as strategic alignment of business and IT-architecture of the global container shipping line on the basis of the formulated Balanced Scorecard [5].

Strategic alignment is a continuous process of adaptation and change in which organizations try to create synergies between their position within their competitive environment and the design of the appropriate structure to support the execution [6]. This process for global container shipping lines is impossible to maintain without a special tool designed to provide adequate assurance that objectives are being accomplished.

The purpose of this paper is to propose a company digital twin concept, which could provide substantial support during the global container shipping line digital transformation.

2 Materials and Methods

The Enterprise Strategic Alignment Method (ESAM) represents a cross-domain approach to the company business and IT architecture alignment in order to achieve its strategic objectives. This method combines such discipline approaches as Strategic Management, Capability Based-Planning, Enterprise Architecture and Enterprise Portfolio Management [7].

ESAM presents the company's business model as a subject area, allowing to coordinate all the company's transformation strategic stages in accordance with its changes. ESAM defines ten strategic stages, for the purposes of this paper the following were considered during the stage of strategic measurements and metrics and their changes during the company digital transformation. 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 [8–10]. This technology becomes an effective tool for high-tech product development and real-time enterprise or process management.

A multi-level matrix of targets and resource constraints (real, financial, technological, 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.

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 suggested. These tools enabled to ensure information support and to track the impact of IT-architecture changes on company's performance.

3 Results

The Balanced Scorecard for a global container shipping line digital transformation was previously described by the authors [5]. For the global container shipping line Balanced Scorecard formation, the concept of shareholder value added management (SVA), formulated by Rappaport [11, 12], as well as Norton and Kaplan Balanced Scorecard were adopted [13, 14].

The Balanced Scorecard financial perspective represents the goals of the company's operational, financial, and investment activities, in addition, strategic goals for the company financial position are defined, too. The digital transformation strategic goals are defined, their achievement will increase the global container shipping line shareholder value. These goals are divided into strategic goals for each perspective—customer, internal process, learning and a growth perspective with the help of drivers that influence each perspective strategic goals achievement.

The customer perspective drivers reflect current trends in the supply chain marketing environment. To define the customer perspective strategic objectives, it is necessary to apply the Marketing-Mix strategic model and metrics of strategic and digital marketing [15, 16].

The internal process perspective is based on Supply Chain Operations Reference Model, the reference framework, recommended by The Supply Chain Council [17, 18]. The internal process perspective drivers according to the SCOR model are defined as performance, processes, practices, 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 internal process perspective indicators with other Balanced Scorecard indicators therefore the SCOR model becomes an effective tool during the company's digital transformation. Besides, the internal process perspective was supplemented by indicators of the BIMCO Shipping KPIs Standard, IMO Standard, capacity management metrics [19, 20].

Learning and growth perspective drivers are people, infrastructure and technology, and culture. During the global container shipping line digital transformation, it is necessary to define strategic indicators, initiatives and challenges of the IT-architecture and ensure that changes to the IT-architecture are implemented and monitored through the necessary organizational structure and expertise. The COBIT standard and the ITIL library, as well as existing frameworks, standards and quality control systems, can provide significant support in this regard [21–25].

The developed reference models of the Balanced Scorecard strategic maps are able to not only assess the impact of the IT-architecture change on the financial, customer and internal process perspective, but also to provide project management during the global container shipping line digital transformation.

Figures 1, 2, 3 and 4 represent the digital transformation strategic goals and drivers for each perspective of the global container shipping line Balanced Scorecard, which are broken down then into strategic indicators.

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

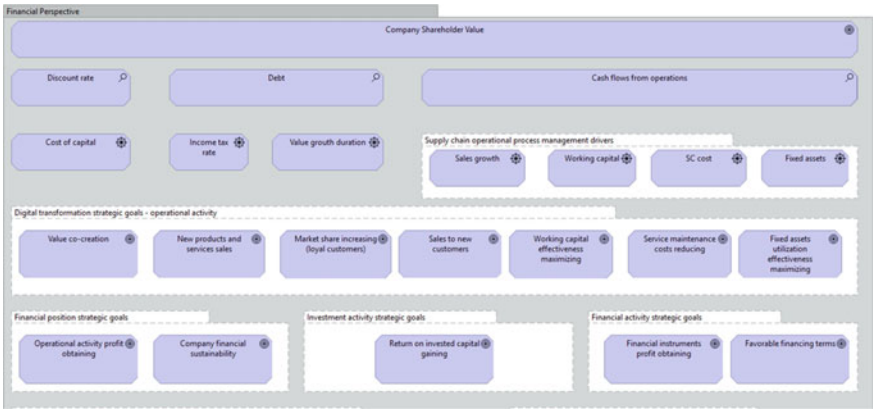

Fig. 1. Financial Perspective: Strategic goals and drivers of the company digital transformation

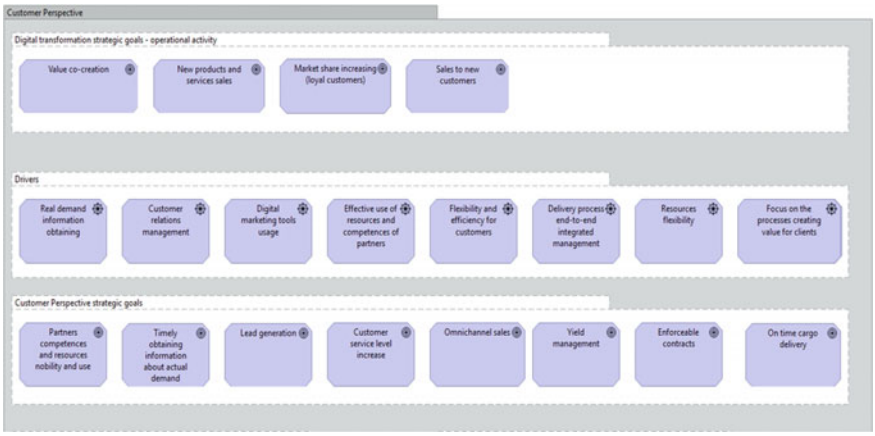

Fig. 2. Customer Perspective: Strategic goals and drivers of the company digital transformation

within IT-project or IT-process. Nowadays the IT-project management problems could be defined as following: the ambiguity and complexity of selecting indicators for tracking; the difficulty of interpreting the results and the obtained data usage for the IT-project development prognosis.

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

This paper suggests the use of ontology to standardize the knowledge collection and presentation approach. Ontology (in computer science) is an attempt to detail and comprehensively formalize a certain field of knowledge using a conceptual scheme. One of the main advantages of using ontology is the ability to combine information obtained from various information sources. The ontologies usage will create a unified

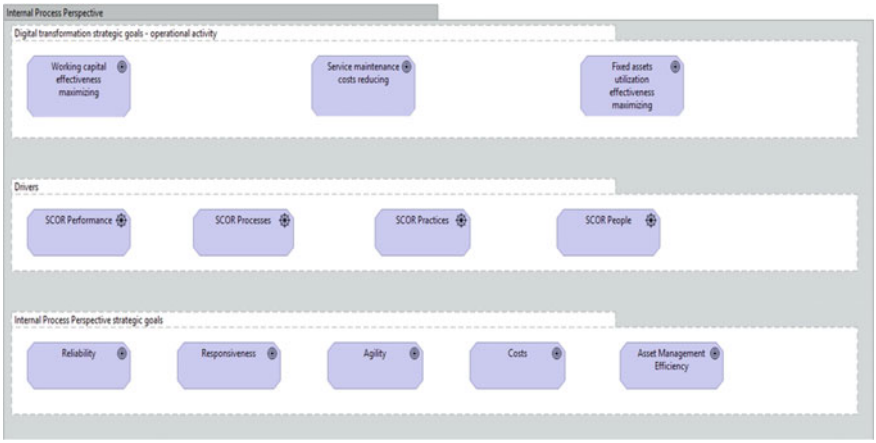

Fig. 3. Internal Process Perspective: Strategic goals and drivers of the company digital transformation

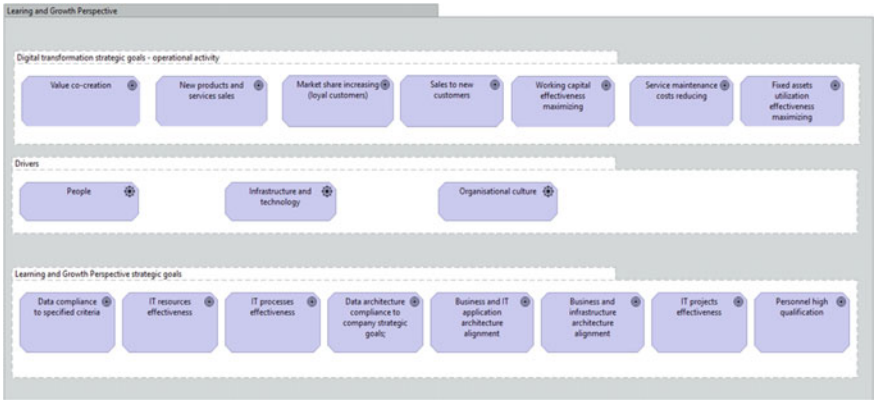

Fig. 4. Learning and Growth Perspective: Strategic goals and drivers of the company digital transformation

knowledge database containing 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

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.

The proposed ontologies used are based on the developed reference models of the Balanced Scorecard strategic maps that can become a basis for the global container shipping line "digital twin" creation. A company's digital twin is a dynamic data-driven software model for representing and analyzing the organization's activities, its current business model, and which can be used to respond to changes in the external and internal business environment.

To create the company's digital twin, it is needed to correlate a large number of strategic indicators, risks and constraints, forecasting precedents and IT-architecture reference models. Figure 5 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.

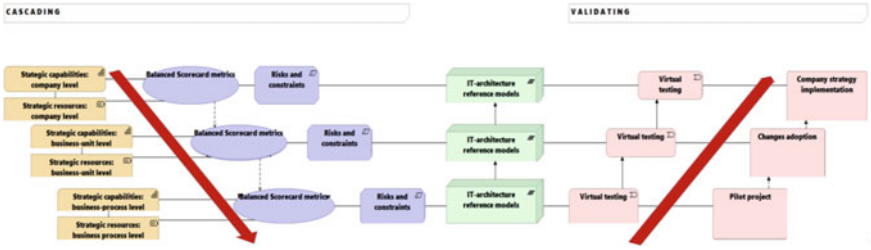

Fig. 5. Multi-level matrix comparing and linking indicators and IT-architecture models of the global container shipping line

As a result of this process, a large numbers of indicators and models balance is ensured, while initially they can "conflict" with each other.

The strategic indicators cascading takes place from the top down, from the company level to the level of the business process, since the global container shipping line implements a unified strategy for all business units. Balanced Scorecard metrics are correlated with risks and constraints, as well as with 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. 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 of prognosis and actual indicators.

This approach is an effective tool for planning, implementing and monitoring of the strategic changes in the context of the global container shipping line digital transformation, allows to avoid errors and inefficient management associated with incorrectly selected strategic indicators, as it will allow analyzing of the impact of a significant number of indicators on achieving strategic goals, as well as adjusting the strategy due to changes in external and internal capabilities and resources.

4 Discussion

This paper proposes the Balanced Scorecard as a basis for IT-architecture modelling, as well as multi-level matrix comparing and linking indicators and IT-architecture models as a part of the global container shipping line digital twin for the purposes of digital transformation. However, this study is not considering another part of digital twin technology: artificial intelligence methods, which could be applicable for analysis and prognoses during global company IT-architecture modelling and development. These methods are the subject for separate research.

5 Conclusions

Thus, the global container shipping line digital transformation requires digital technologies introduction in all aspects of the company's activities, the Balanced Scorecard can provide significant support in modelling and analyzing of the latest technologies introduction results. To align the company's business and IT-architecture, it is relevant to use ontologies of strategic indicators, risks and restrictions, forecasting methods and company's IT-architecture reference models as well as multi-level matrix comparing and linking indicators and IT-architecture models.

By using of the proposed in the current paper tools, it is possible to create a company "digital twin" that will ensure information support and tracking the impact of IT-architecture changes on company's performance.

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