Assessment Report

Digital Situation Assessment of JS Georgian Railway

FINAL REPORT
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Glossary

Abbreviations

ABAP	Advanced Business Application Programming
API	Application Programming Interface
BI	Business Intelligence, set of processes, architectures, and technologies that convert raw data into meaningful information that drives business actions.
CRM	Customer Relationship Management
CSF	Critical Success Factors
DB E&C	Deutsche Bahn Engineering & Consulting
EBRD	European Bank for Reconstruction and Development
ERP	Enterprise Resource Planning
eGA	e-Governance Academy Foundation
EU	European Union
GPS	Global Positioning System
GR	JS Georgian Railway
HANA	High-Performance Analytic Appliance
HP	Hewlett-Packard
HRMS	Human Resources Management System
HR	Human Resources
ICT	Information and Communication Technologies
IM	Infrastructure Manager
IT	Information Technology
MS	Microsoft
MVC	Model–View–Controller

OLAP CUBE	Online analytical processing, computer-based technique to analyse multi-dimensional array of data
OS	Operating System
OSJD	Organization for Co-operation Between Railways
RA	Railway Administration
RU	Railway Undertaker
TAF	Telematics Applications for Freight Services
TAP	Telematics Applications for Passenger Services
TSI	Technical Specifications for Interoperability
SAN	Storage Area Network
SAP	Systems Applications and Products in Data Processing
SLA	Service-Level Agreement
SQL	Structured Query Language
VPN	Virtual Private Network

Terms

application	software that is dependent on the services of an operating system
automatic/automized	Automatic - some decisions in this process are made by the system or application automatically, based on data and guided by a formulated model (algorithm). Implied that automated process model does not include cross-process influence and takes into account only this process incoming data and this process "influence factors".
cybersecurity	(a) the security of cyber devices and (b) security against threats created through the operation of cyber devices. Security usually means a situation where risks are not materialized
data	reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing
digital document	in the digital document, the data is presented in a machine-processable form. Digital documents can be used for automated analyze process.
digitization	Process of converting information into a digital (machine-readable) format
digitalization	Use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business
data exchange	Storing, accessing, transferring and archiving of data
digitally transformed processes	digitally transformed processes is a set of processes that takes place entirely in a digital environment, while it also communicates inside the same digital environment.
e-governance	electronic governance, the application of information and communication technology (ICT) for delivering government services, exchange of information, communication transactions, integration of various stand-alone systems and services between government-to-customer (G2C), government-to-business (G2B), government-to-government (G2G) as well as back-office processes and interactions within the entire government framework
e-services	library services delivered via electronic means, whether from local servers or provided via networks
interoperability	ability of two or more systems or components to exchange information and to use the information that has been exchanged
1C: ITIL	solution for the IT service of the enterprise

Executive Summary

Experts from the e-Governance Academy carried out the Digital Situation Assessment of JS Georgian Railway (hereinafter referred to as GR) between July 2021 and January 2022. The main outcome is the current Digital Maturity Assessment Report.

The report is the product of desk research, questionnaire responses (see Annex 1), outcomes of on-site mission meetings (including ICT system demonstrations and oral interviews), analysis of the documentation provided by GR, and additional information obtained via e-mail and conference calls. Annex 2 contains the mission`s agenda.
The analysis focused on the assessment of digital maturity in five key critical areas - business determinants; strategy development; business and operational processes; organizational culture; and information technology. The report summarizes the current state of digitalization and makes critical recommendations for the company`s long-term digitalization strategy. The proposals are based on world-wide best practices and would assist GR in maturing its e-governance capabilities.
GR has made significant strides in recent years in terms of modernizing the organization. According to the model described in Chapter 8, the maturity of GR is classified as “Digitally Reactive” (second level out of five).
To take digital transformation to the next level, it is recommended to implement a set of activities, beginning with:

- Formalization of the enterprise strategy. Development of an information technology plan and a strategy for digital transformation, based on the GR’s business strategy.
- Standardization and digitization of business operations, with a particular emphasis on those connected to the enterprise`s core service provision: maintenance of infrastructure, traffic control, freight transportation service, and passenger transportation.
- Extend the scope of current risk assessment.
- Establish a culture of data-driven solution automation. Managers at all levels must be able to justify their actions with unambiguous references to data (BI platform) that is accessible to other decision makers and stakeholders.
- Adopt a proactive approach to employee digital skill development. This includes adopting practical skills in digital security and cleanliness as quickly as possible, as well as gradually improving general skills of abstract thinking and the use of analytical digital tools.
- Establish means of interaction with clients and partners, as well as automate the collecting of feedback from users of all GR’s services (incl. internal users).

There is a readiness for change among key GR personnel and a desire to implement the digitalization of the processes. This, combined with their advanced competencies, is a critical aspect in ensuring the success of digital transformation.

1. Introduction

1.1. Background

Georgia has undertaken a series of reforms and policy steps in recent years to improve the business and investment climate, including significant investments in the country`s transportation infrastructure. Building on this success, the Government is committed to transforming Georgia into a regional logistics hub, fully utilizing the country's advantageous geographical location between Europe and Asia along the Trans-Caucasus Corridor, in order to contribute to long-term sustainable economic growth, job creation, and living standards improvement. To accomplish this, further efforts will need to be made to strengthen Georgia's transportation infrastructure and services, particularly in terms of the efficiency of information technology and telecommunication systems, technologies, and applications in GR. This aim is consistent with the EBRD's strategic targets in Georgia, which include market development through interregional connectivity and strengthening private sector competitiveness. Additionally, it is consistent with the EBRD's 2021-2025 Strategic Capital Framework targets, which include supporting Georgia's transformation to a digital and green economy.

The Georgian Partnership Fund, the state-owned investment fund of Georgia, is the GR's sole stakeholder. It now holds a monopoly on Georgia`s rail transport business. The company is the largest employer in the country, employing approximately 12,000 people across three business units: infrastructure, cargo, and passenger transportation.

To gain a better understanding of how digitization can optimize time and costs in relation to various systems and services used and provided by the company, GR conducted a comprehensive internal technical audit and risk assessment of its core IT/SAP/telecom systems, infrastructure and services in 2020. This technical audit uncovered current gaps and highlighted the importance of developing and implementing a long-term strategy and organizational model to improve GR's digital transformation. GR now requires assistance in two areas:

1. developing a digitization strategy that establishes a framework, roadmap, and milestones for the organization`s digital transformation; and
2. defining an appropriate organizational model for the organization that enables effective (i) implementation of the digital transformation strategy and (ii) coordination and engagement of the relevant stakeholders.

An analysis of more than 400 large companies from different industries, carried out jointly by Capgemini Consulting and MIT Sloan Management shows that enterprises actively using digital technologies and new management methods are on average 26% more profitable than their competitors. More conservative companies, which improve only management, increase their profit by 9%. Organizations that invest heavily in digital technologies but pay little attention to governance are not able to gain synergy and create significant additional value based on digital applications. They have 11% lower financial ratios. And finally, companies that do not sufficiently use both the potential of digital technologies and have strong management capabilities, are on average 24% less profitable. As a result, there are clear commercial benefits to digital transformation, and assessing a company's digital maturity should include an assessment of its preparedness to change how fundamental business operations are managed, as well as its readiness to adopt new digital technologies.

1.2. Objectives

The overall objective of the assignment is to produce a Digital Maturity Assessment Report. This Assessment appraises the company's current state of digitalization with a particular focus on business relevant e-services; provides recommendations to maximize the impact of existing digitalization efforts; identifies new areas for digitalization; and proposes an organizational model for optimizing stakeholder coordination and enabling GR to successfully implement comprehensive digital transformation.

The Digital Maturity Assessment Report cab be used as a foundation for developing GR's long-term digital transformation plan. Additionally, the report will define the extent of work required to create and implement the recommendations.

1.3. Methodology

The Digital Maturity Assessment will set the basis for the development of a long-term strategy for the digital transformation of GR. The analysis will be conducted using eGA's own Digital Maturity Assessment methodology and a widely used approach developed by MIT/Deloitte (2017) for analysing GR as a business. The methodology comprises five categories:

- business determinants (including political will and support, interaction with national and international legal frameworks, interaction with customers, current and projected traffic structures),
- company strategy and model (incl. functional strategies, organizational set-up, financing model),
- business and operational processes (incl. methodology of management, changes implementation methodology, etc.),
- organizational culture and personnel (the level of readiness of employees to change, the level of digital competences and capacity, the availability of the necessary personnel in the labor market),
- information technology (digital databases, interoperability, secure data exchange, information security).

The assessment focused on the readiness of business processes for digitalization, the availability of necessary information infrastructure, and the availability of the necessary data. A critical component of the digital transformation is the organization`s management and relevant staff`s readiness. Additionally, the readiness analysis of the personnel also draws conclusions about the additional risks associated with further digitalization.

Likewise, the report analyzes the readiness of information systems to be separated following the anticipated liberalization of the transportation market (separation of the infrastructure, passenger transport and freight operations; readiness to serve other freight operators).

The data collection process was mainly based on:

- existing documents (policy documents, strategies, and the agenda of the company), public statistical sources, studies, and indices, among others;

- responses to questionnaires that mapped the existing digital landscape in GR among key stakeholders;
- responses to interviews conducted during the mission to Tbilisi, Georgia on September 20-23, 2021; and
- additional information requested following the mission.

2. Business Determinants

2.1. Expectations for Digitalization

Current Situation

The Georgian Partnership Fund that owns 100% of GR shares and is a state-owned investment fund has not adopted administrative acts that set any official requirements for the development of digital services in GR.

GR's desire to digitalize business processes does not come from external requirements, but from the understanding of the management and key stakeholders that digitalization will improve business efficiency and create stability. The top management of the GR supports digitalization processes and views it as an opportunity for the future, but the digitization process is not written down in a binding document.

In the digital transition, the following factors that are common to the railway industry, should be also considered:

- the market structure of a natural monopoly (from historical and geographical reasons);
- high volumes and long payback period of investments;
- political influence, direct or indirect regulation by the government.

There are other government institutions offering digital services to GR that also influence the standards of GR digital services. For example, information is shared with the Georgian Tax and Customs Policy Department's information system, where the documents related to the internationally transferred goods are managed. Such documents (invoices, packing lists, certificates of origin, etc.) are digitally transferred from GR to Georgian Customs in paperless format. The documents are not machine-readable, but in the form of scanned copies of the paper documents. This method speeds up the document management process and reduces the use of paper documents but does not automate the information management processes and does not provide the possibility of digital interactions and data analysis. Therefore, the system also limits the possibilities for GR to benefit from the system in its digitization process.

Recommendations

The environment where GR operates (expectations from government, possible reforms, legal framework, etc) will also affect the digitalization processes of the company. The expected

actions are listed below in the order of their occurrence as chains of source factors and requirements for digital transformation areas:

- Division of the enterprise into parts → The infrastructure company`s costs are constantly monitored and regulated. → More transparent (and preferably automated) reporting is required.
- Enterprise division → Infrastructure requirements for accurate information sharing between participants in a competitive transportation process→ Requirement to develop a transportation process model (by business roles). Enterprise division → Infrastructure must be in place to ensure that information is shared correctly between competing railway undertakings → Information protection and distribution, as well as a data exchange strategy, are required.
- Segmentation of the enterprise → Separation of data networks → Physical proximity of communication lines and data centres → Requirement for reliably separated and protected networks.
- Increased competition → The requirement to compete for customers → The requirement for more flexible service provision and the development of new products, e.g. digital models with predictive capabilities.
- Increased competition → Requirement for increased investment efficiency → Requirement for cost savings → Necessity for equipment life cycle optimization.
- Increased competition → Requirement for increased investment efficiency → Requirement for optimizing (changing and possibly automating) business processes, including data collection and aggregation from multiple sources.

2.2. Legal Framework

Current Situation in GR

Currently GR activities are influenced by three different legal ecosystems:

1) Legislation of Georgia.
2) Guidelines provided by the Co-operation Between Railways (OSJD), total of 70 regulations (as of January 2021). For example, the rules for the use of transportation documents, including paperless ones, are outlined under the Agreement on International Rail Freight Traffic.
3) Additionally, GR takes part in the Council for Rail Transport of the Member States of the Commonwealth, where the technical operating conditions and the rules for rolling stock accounting are quite strictly regulated, especially for the railway administrations located at the border crossings. As of the beginning of 2021 there were a total of ~480 regulations and guidelines, including ~130 regulations in the IT field.

The Georgian Government plans to formally apply for European Union (EU) membership in 2024, which will also affect the legal framework for the railway transport sector in Georgia. The main challenge for ongoing public reforms is the alignment of the Georgian legal and institutional framework with EU legislation, including the expected opening of the rail freight market.

Therefore, GR is currently having discussions on its options should there be a need to separate infrastructure and railway undertaker (carrier) businesses. The main benefit of the separation is to improve transparency of tariff setting and its management.

At the time of writing the report, the final decision on the separation and the new possible organization structure had not yet been made. However, these decisions will influence the legislative framework where GR operates, the information systems used in GR, process descriptions where information systems are used, and the company's digital transformation efforts.

But the decision to separate the financial flows of the infrastructure, and passenger transport businesses in 2022 has already been made.

Recommendations

To prepare for the open market, GR should:

- Develop a business model based on the definition of transportation process roles (infrastructure manager, railway undertaker, rolling stock fleet manager, wagon repair enterprise, and so on) in order to align the requirements of the various legal ecosystems in which GR operates.
- Ensure maximum transparency for all customers regarding tariff components and the tariff setting process, particularly for infrastructure services tariffs.
- Promote a data-driven decision-making process, as this will assist in reducing employee work time, which is a result of the complexity of requirements under various legal systems. For instance, numerous requirements imposed by various legal systems (OSJD, Council of Rail Transport) can be met through varying degrees of implementation. A data-driven decision-supporting system will assist in selecting the objectively best implementation option for the business, while maintaining a transparent and non-subjective decision-making process. Data-driven decision-making models will enable objectively estimating the impact of different implementation options on the business with a minimal amount of work time. Additionally, data-driven solutions (as the first step in digital modelling) will enable an objective assessment of the business impact of function redistribution between GR branches or between separate enterprises. This type of redistribution is unavoidable in the near future, as a result of enterprise division and the emergence of alternative competing carriers.
- Invest in increasing the efficiency of the stakeholder supervision by automating processes at all levels, beginning with data collection automation and progressing to digital modelling for various solutions and possible scenarios for enterprise services/products development. Owners and investors, customers and suppliers, employees, and broader community are all relevant stakeholders who must have access to clear and informed decisions that affect them. Without process automation, this type of information segregation will be extremely time-consuming.

2.3. Interaction with Customers

Current Situation in GR

The GR's "external" customers are primarily divided into two categories:

- Passenger transportation and support services customers (passengers, ticket agencies).
- Recipients of freight transportation and supporting services (shippers, freight forwarders, neighbouring infrastructures, such as port terminals, etc.).

This is a common occurrence for railway companies that enjoy a natural monopoly in their respective countries. However, it may be relevant to include internal users who access the company`s internal digital services in the customer ecosystem. This model is more universal: it will remain largely unchanged in the event of an enterprise`s division or reorganization. Additionally, an expanded definition of "customers of GR's digital service" will aid in the division of GR`s internal costs and the development of a more transparent model for financing digital processes.

As such, the term "GR services customer" refers to all internal and external users who consume GR units` services.

To determine an organization`s level of digital maturity, it is necessary to examine the extent to which internal documents have been digitized – that is, whether the documents have been converted to a paperless format (digitized or partially digitalized). In GR, documents and processes have been largely digitalized, but process automation is limited. This has an effect on *internal customer* experience.

The process of communicating with *freight transport customers* is partially digitalized (for example, procedures such as" Registering of freight transportation orders," "Consignment order registration for local transportation," etc.).

Besides that, the main customer interaction processes associated with *passenger transportation* have been digitalized (processes such as buying or returning tickets). Considering that digital services related to passenger transportation are augmented by the capabilities of partners' information systems (ticket agencies that interact with the Orion system via the API), it is possible to assert that digital transformation occurred during this process.

However, feedback from customers and partners via external systems is either not processed at all or is processed in an inefficient manner. GR collects customer feedback via a hotline, Facebook comments, and other methods, and manually enters data into pertinent reports. This is an inefficient method of data collection and processing.

Based on the interviews, GR employees make service development decisions based on their own personal experience and anticipatory behaviour, rather than using algorithmic decision-making, because the feedback data is not machine-readable.

This approach does not allow for an accurate and objective assessment of the entire cycle of customer and partner interaction, including a quantitative assessment of the impact of certain decisions. Additionally, this approach runs the risk of placing undue reliance on the skills of key specialists.

Recommendations

Monitoring social media is an integral part of relationships with users and partners and the most effective method of obtaining objective feedback. Here are some examples of what GR can accomplish through the use of very common social media monitoring tools:

- Keeping an eye on the customer experience. How do your customers perceive you? Are they speaking positively about you? Perhaps they are complaining? Have they had any positive experiences? These answers are simple to obtain through the use of pre-built social media monitoring solutions.
- Gathering customer feedback. GR can learn new aspects from customer feedback by adjusting its search algorithms. As a result, the company is able to implement the changes that users and customers expect. Additionally, this allows for the possibility of targeting the desired audience with messages that are relevant to them.
- Developing the GR brand. Evaluate the GR brand`s strength and, if necessary, make adjustments and switch communication channels.
- Competition monitoring. Maintaining an eye on competing brands, services, and railway-related information will help in establishing a foothold in the railway industry, especially among neighbouring countries.
- Monitoring industry influencers. Analysis tools will enable the monitoring of industry influencers and advocates` opinions and, if needed, the establishment of a channel of communication with them.

Likewise, it is recommended to invest in the automation capabilities of tools that analyse and synchronize the objectives and performance of business processes related to the customer experience. This enhances GR`s ability to enhance customer experiences and make data-driven decisions.

The following category should be added to define the customers – internal customers: GR business units that are consumers of GR's services.

3.Strategy and Business Model

3.1. Strategic Planning

Enterprise IT strategy and its relationship to business strategy are critical because, in rapidly changing market conditions, IT departments must adapt rapidly to changes in enterprise strategy. However, analyzing business requirements, a company's readiness for digital transformation, and the associated costs of developing an IT solution is a time-consuming and complex process. As a result, its implementation is fraught with difficulties.

A digital transformation strategy is a plan outlining how a business intends to leverage digital technologies to further its overall objectives. It may provide company with a more comprehensive view of the role those digital technologies can play in defining and executing the business strategy. In contrast to an IT strategy, it engages in a two-way discourse with the business strategy. Digital transformation strategies have the potential to influence and guide the business strategies, and vice versa. Additionally, IT and digital transformation should be integrated into the enterprise`s core strategy.

Therefore, defining and implementing IT and digital transformation strategies is the only way for organizations to achieve their business goals in today's fast-paced world.

Current Situation in GR

The analysis discovered no information on written strategy documents such as business strategy, IT strategy, financial strategy or digital transformation strategy.

The World Business Solutions Branch uses a risk assessment titled "Recognizing and minimizing risks" from 2020 to plan strategic activities. The analysis revealed six risks related to the security of IT infrastructure and network resources:

- The risk of losing communication capability (associated with an outdated telephone system);
- The risk associated with the physical and logistical data transmission network connecting the central office, the main data centre, and the backup data centre (the time required to switch to the backup data centre was 8 hours);
- The risk of losing Internet connection (Internet connection is provided by a single provider);
- The risk of losing communication due to network interruptions at the regional stations;
- The risk of compromised authentication on network resources; and
- The risk of compromised VPN usage (insufficient one-factor authentication with password).

According to interviews, these risks have already been minimized or eliminated or will be by the end of 2021.

The risk list (which is not included in the official document) does not include any financial, property or organizational, or other risks that are inescapable for the GR as a fixed asset-intensive enterprise. Risk analysis should be performed on business units as well. For example, freight transportation has increased the volume of basic services significantly, introducing a number of risks that should be addressed. Obviously, there are legislative, marketing, and possibly political risks associated with a possible rail transport sector reform.

Recommendations

To gain a holistic view of GR`s strategic developments, including digital transformation requirements, it is critical to create strategy documents outlining the means by which the company will accomplish its mission, which is stated as "*Through the development of transit*

corridors, the modernization of railway infrastructure, and ensuring affordable passenger fees, the company supports the state's security and sustainable economic development".

The simplest way to develop a mission-based strategy is to identify the enterprise`s critical success factors (CSF). Given that GR has already conducted some analytical work through risk assessment, developing a strategy based on the CSF will be a logical continuation of that work. The process of developing the strategy will also serve as a continuation of the risk assessment.

The company`s IT strategy and digital transformation strategy should be formalized and revised on a regular basis by relevant internal stakeholders. The strategies should be accompanied by well-communicated action plans to the employees.

3.2. Organizational Set-up

Current Situation in GR

While the current IT organization is primarily focused on addressing digital transformation challenges, some areas require additional resources, most notably process analysis and modelling competences are not yet at a level that enables the fulfilment of ambitious future strategies.

Additionally, the software development team should be involved in the development of projects on a more permanent basis, rather than on an ad hoc basis. While the current ad hoc method enables rapid response to new requests from business units, evaluating the team`s overall IT and digital transformation strategy requires a different setup.

In the strategy of organizational set-up, when planning the structure of the enterprise and the distribution of functions between departments (which should be defined by internal processes), the forthcoming changes in legislation governing railway transport in Georgia should be taken into account.

Recommendation

To give detailed recommendations to GR require careful analysis of the specifics of Georgian legislation, which is beyond the scope of this assessment. But some recommendations can be made based on the experiences of other railway enterprises that have undergone similar changes – separating the infrastructure manager (IM) and railway undertaker (RU). These recommendations are in Annex 3.

3.3. Financial Model for Digital Transformation

To ensure sustainability in a digitally mature organization, general financing and financial models for e-services must be developed. The total cost of ownership of any digital solution must be planned. The implementation of digital solutions will incur costs, even if they quickly result in cost savings in other areas, and it is critical that the necessary funds are provided in a sustainable manner. Sufficient financing should be provided over the medium to long-term, preferably via multi-year budgeting. To facilitate that allocation, it is necessary to establish

clear procedures for planning the digital transformation budget and managing the use of budgetary resources. The financial model`s transparency and accountability must be ensured.

Current Situation in GR

The digital development projects for business activities are included in the annual budget of the World Business Solutions Branch. The related activities and finances are planned reactively on an ad hoc basis in response to requests from the business units or the Branches own assessment of IT trends and potential needs of business units. There is currently no strategy document for financing digital transformation projects.

This ad hoc model precludes the establishment of self-sufficient digital business structures capable of implementing buy-in principles and act in a sufficient speed to respond to user demands, changes in the ecosystem of partners, and the actions of competitors (currently, only road transport companies are in relative competition with the GR, but if the railway sector reforms are implemented, direct competitors will emerge in freight and passenger railway undertakers).

At the same time, the current strategy for financing IT services and initiatives is generally acceptable for a stable market organization and may even be acceptable for monopolies such as GR, owning to a stable income flow, the absence competitors in the railway sector, and a lack of massive infrastructure development. Additionally, it simplifies the management of IT finances, but it constrains the scope, speed, and innovation of IT initiatives, and will require replacement in the future. This model does not support the implementation of long-term IT and digital transformation projects.

Recommendation

It is Important to develop a long-term strategy for financing projects involving digital transformation in GR.

Especially if the railway sector is reformed and the railway transportation market is liberalized, stability factors will be eliminated. Then the described reactive approach will not provide IT structures with timely signals about the correct "critical success factors" of the enterprise.

The formation of critical success factors will significantly increase the flexibility of financial planning, including the possibility of independent budgeting for horizontal digitalization teams, which, as mentioned above, is severely limited by the current reactive financial strategy. The creation of such a document (and the procedure for its regular revision) will enable GR to begin proactive improvements in financial planning: the budgets for digital services and digital teams are contingent on ongoing annual budget negotiations.

A financing strategy for digital transformation should also include a model for evaluating the impact of digital transformation on enterprise operations, as monetary value is the simplest and most universal metric for evaluating the success of digital transformation (although it is not recommended to limit the assessment to this as the only means).

Without conducting extensive research, specific methodologies cannot be recommended, but based on best practices, such financial models (including the impact of digital transformation) as combination of the following can be recommended:

- economic impact assessment (impact on the company`s economic performance, including operational and capital costs, revenue, and profit) of the digital transformation strategy`s implementation and the need for investment, which includes forecasting (and calculation for prior periods) of the integral economic indicators of the digital transformation strategy. We also recommend calculating indicators for each initiative of digital transformation and then calculate strategy indicators as the sum of all initiatives.
- prospective sources of funding for initiatives and activities of the digital transformation strategy. The funding sources for various initiatives within the digital transformation strategy must be justified, including the aspect of utilizing different sources based on the maturity of digital technology (research, demonstrated effect in industry, etc.) and the stages of implementation of digital solutions (development, piloting and widespread implementation etc.). Over the past periods, the actual used funding from various sources has to be reflected.
- assessment of the economic efficiency of the implementation of the digital transformation strategy i.e., the calculation of indicators of return on investment in digital transformation using the data from the subsection "Assessment of economic effects and the need for investment". Likewise, this subsection entails a comparison of the GR's investment activity in the area of digital transformation with comparable regional and global practices (sources). The recommended metric is Digital Transformation Investment to Revenue Ratio. GR should select companies and data sources for comparison. Other railway enterprises on the territory of the post-Soviet space, can serve as a model for adjusting their level of digital maturity to European "best practices" and recommendations. These enterprises share an approximately equal starting point and a similar business model, as well as comparable investment proportion requirements for fixed assets, with the GR. Between 2022 and 2024, some of these enterprises plan to invest between 2% and 7% of total investment in digital transformation.

Tables illustrating the three recommended components of a digital transformation financing model are provided in Annex 4. Table 37 summarizes the various funding sources for digital transformation initiatives and activities related to the GR's status as a state-owned enterprise; however, consideration should not be limited to the sources listed.

As noted above, the choice of specific methodologies applied are beyond the scope of this report. When calculating the effects, it is important to follow established corporate practices and methodologies for assessing economic effects in the context of current operating and investment activities. Additionally, GR is responsible for selecting the methodology for calculating investment efficiency.

4. Business and Operational Processes

Digitalization, in general, should contribute to stability of the business and operational processes, as well as the simplification and transparency of data exchange within an enterprise.

In terms of supporting processes, the internal document flow should be digitalized to the greatest extent possible. This will accelerate and simplify processes, as well as improve the transparency of document management and decision-making. Additionally, this will pave the way for future steps in process automation and digital transformation.

4.1. Enterprise Operational Processes

Although GR employees have a good understanding of the activities required to be performed within operational processes, these activities are not necessary described in the procedure documents.

A significant number of supporting processes and some critical (railway-specific) business processes have already been digitalized, but they are not automated. To reap the full benefits of digital transformation, processes should be automated to the greatest extent possible. The first step can be to transition to paperless versions without significantly changing the business process or tasks themselves. The primary aim would be to analyse processes in order to elevate activities through digitalization, but this is more time-consuming process.

4.1.1. Supporting Processes

Current Situation in GR

A large part of the supporting processes (for examples processes as "Execution of the planned order", "Receipt of materials" and "Budget planning") are formulated and described in the form of SAP design solutions. The processes associated with planning and using materials in repairs are also formalized and digitalized.

At the same time, the respondents noted that the planning of the materials, for example, for the repair of the signalling and communication systems, proceeds mainly according to the principle of the planned service life. This means that decisions are not based on the current data. Data on the state of the devices and statistics of device failures are not collected in uniform digital form and are not analysed. This approach (based on planned service life) provides a certain level of stability of the infrastructure service but does not have the potential for process optimization. Also, the lack of data on the current state of devices will not allow improving the quality of the service through the use of predictive algorithms.

When reviewing the documents that describe the processes, it was noted that there were contradictions in the descriptions of process interaction with other processes. For example, the process description of "Receipt of materials" says that the interaction with the state procurement agency occurs not in the form of electronic data, but in the form of documents outside of electronic systems. At the same time, this process description mentions the neighbouring process "Integration of Consignment Notes with the RS.GE website". Such a contradiction suggests that each of the processes is considered and documented separately, and there is no holistic view of the set of processes.

Despite the generally well-understood strategy of abandoning paper documents in favour of electronic data in GR, it can be noted that in some internal processes electronic document management is not used widely enough. For example, internal documents (such as design solutions for business processes) went through registration and approval procedures within

the enterprise completely as paper documents, judging by the handwritten edits and ink signatures of the responsible persons. In addition, respondents noted that they could not perform some part of work remotely due to a significant number of physical (paper) documents.

Recommendation

It is reasonable to assume that the direction chosen - the maximum digitalization of the internal document flow - is a promising one for the enterprise`s development. It will accelerate and simplify processes while increasing transparency in document management and decision-making.

4.1.2. Traffic Management

Current Situation

Traffic management and transportation security are two critical infrastructure services.

Railway-specific processes such as traffic planning, or more precisely, the scheduling and cancellation of freight trains, the development of timetables, and so on, are entirely handled on paper in GR. These are the most technologically complex and time-consuming processes.

However, some security-related processes have been partially digitized and are managed through information systems. Despite the fact that there is a software module in place for informing locomotive drivers about infrastructure constraints ("Electronic warning management module"), locomotive drivers receive and sign paper documents.

In general, the digitalization of the processes associated with traffic planning and traffic control is in its early stage, with no clear plans for optimization or automation. Traffic planning includes developing a basic schedule and monitoring its evolution over time in response to various factors. Despite its complexity, this process is quite algorithmic in nature and consists primarily of data-driven decisions. Performing this process manually is time consuming and inefficient. In current conditions, with the traffic intensity on the GR infrastructure constantly increasing, manual execution of this process causes operational risks as well as reputational risks. With the emergence of competitive carriers, penalties become a possibility.

Traffic planning processes are not fully formalized in GR. Formalization and digitalization of these processes is an urgent task within the framework of the risk mitigation program adopted by the GR and can be recommended as one of first goals of digitalization.

Recommendation

Digitalization of the traffic control process is a much more difficult task that cannot be accomplished without significant investments into the technological component (dispatch centralization). As a result, process digitalization cannot be recommended as an immediate goal. However, formalizing this process enables risk mitigation and lays the groundwork for the next steps in the digitalization and automatization of traffic control.

4.1.3. Freight Transportation Process

Current Situation in GR

The freight transportation processes (see answers in Annex 1, Table 15, Table 16, Table 17, Table 18) section in GR is characterized as follows:

- A good level of digitalization;
- The processes are formalized and significant part of the logic of business processes is implemented in information systems, but the description of processes is not written out in the single formal document;
- Many decisions related to these processes are made manually, despite being inherently data-driven (based on a significant number of specialized system reports);
- Significant part of the processes associated with external customers of GR offer a good level of self-service; and
- Customer feedback is collected manually.

Recommendation

In general, this group of business processes forming together the freight transportation process can be assessed as well-digitalized.

The challenges that await GR in the foreseeable future (they are described in Sections 2.1, 2.2, 2.3), primarily the liberalization of the railway transportation market and the likely emergence of competing railway undertakers, imply a significant change in the requirements for information systems serving the processes of transportation in Georgia.

To begin, this means that the information systems of GR must be prepared to organize interaction (either at the information system level, via the API, or through the railway undertaker service portal) with all railway undertakers wishing to operate on the territory of Georgia. Obviously, competing railway undertakers should be treated equally. The information must be divided correctly and without violating trade secrets. All communication processes that are necessary for the railway undertaker to perform its functions properly must be serviced.

Taking into account that the information system of GR, serving freight traffic, is currently implemented as a single and, basically, indivisible software system, such requirements cannot be fulfilled without a significant upgrade of the system. The requirements imply the modularity of the system (due to the possibility of splitting the enterprise) and the construction of an APIs system with a precise definition of the rights of subjects to access data and change data.

The development and future maintenance of the entire system will be a monumental task for GR. Modularity of the system and maximum use of customized off-the-shelf components are two of the best practices for simplifying development management. Additionally, it mitigates the risks associated with reliance on unique developers, a lack of competent specialized developers, and significantly increases development speed due to the possibility of sharing

development between independent contractors. The deployment of SAP HANA and OLAP CUBE are steps in this direction. Recommendable is to pay special attention to the possibility of utilizing out-of-the-box customizable solutions during the pre-design phase system analysis. Conversion of message and file formats is an example of this functionality. This functionality is in high demand in transportation management systems, as one of the main services of this system is the exchange of data with information systems of other railways, with the Railway Council`s information systems, and within Georgia - with information systems of Georgian state bodies and with clients. Among the other obvious standard features based on pre-built solutions, it is strongly recommended for GR to utilize the service/features for converting messages and files between various formats (for example, the manager of the ready-made solution for transferring, converting and processing files and messages HULFT). Such standard functions should be recognized and implemented as much as possible during the system design process.

Additionally, the requirements for the business process, at least in terms of freight transport, are quite specific, as GR is required to comply with requirements imposed by multiple legal systems in which GR operates concurrently (see section 2.2). This unique position (namely, the obligatory role of the railway administration in the understanding of the Railway Council) requires coordination in terms of information exchange between carriers. This significantly complicates the tasks of the information system when compared to traditional European processes for coordinating interaction between the infrastructure manager and the railway undertaker. This factor also greatly limits the choice of ready-made solution for software modules supporting critical business processes. It may even be sensible to consider the possibility of using individual modules of information systems from railway enterprises that have to operate under the same legal systems and already have their own transportation management software in the face of numerous competing carriers. At the moment, such systems are in the possession of the railway enterprises of Ukraine, Lithuania and Estonia.

A possible next step in freight transportation processes digitalization would be to introduce data-driven decision-making where possible, using a large amount of data already collected.

4.1.4. Passenger Transportation Processes

Current Situation in GR

Passengers on the GR have variety of options for purchasing and returning their tickets. One possibility is to visit GR ticket offices, ticket machines, or the GR website. Additionally, these activities are carried out by several ecosystem partners (mainly ticket agencies) who communicate with the information systems of the GR through an API.

The processes related to the sale and refunding of the tickets in GR are digitalized at a high level. These processes are largely automated, and the back-office's task is to constantly monitor and modernize these processes and, if needed, make corrections in the information systems.

The disadvantage is that the information carrier (ticket) is only accepted in physical format, while the paperless version (QR or bar code from a mobile phone screen or verification using another digital physical document) is not accepted. If the ticket is purchased via the Internet, it should be printed out.

It`s worth noting that the Orion ticketing system is not compatible with any international ticketing systems (Express in the Rail Transport Council area, as well as other major international systems). Due to the high cost of such integration and the low volume of international passenger traffic on GR, it can only be recommended as a possible direction for business analysis.

Passenger transportation planning processes are not digitalized or formalized, either. Decisions within these processes are currently not made on the basis of formalized data but on the basis of the long-term experience of the management of the business unit.

For customer feedback collection processes, please see section 2.1.

Recommendation

To support the decision-making process in passenger transportation sector, we would recommend creating of a formal description of the data need to support this process. Without additional analysis, only two main common sources of such data can be named - the analysis of influencing factors (development of partner and competing services), as well as massive, systematic and automatic collection of feedback information from consumers of passenger transportation services, which allows to create decision support system based on big data.

4.1.5. Usage and Maintenance of the Rolling Stock

Current Situation in GR

The processes for rolling stock usage and maintenance are only partially formalized. For example, no interaction with a wagon-repair or wagon-building enterprise located outside GR is described.

GR does not provide for a means of digital communication to its process partners. Some of the documents are transmitted in paperless form, but not as data structures. This results in the need to manually re-enter data and does not allow the distribution of responsibility for data correctness with the original source of the data, as well as increases the risk of errors. Furthermore, the absence of true digital interaction precludes the process from being automated.

The priority of digitalizing this process is determined by the volume of interaction with external partners in real time, as well as on the plans for the restructuring of the enterprise. Likewise, it should be noted that the repair of wagons and their registration is strictly regulated by the Railway Council and monitored by its information systems. According to the Railway Council, the railway administration is obliged to provide functions for the exchange of information with the central wagon data filing system when changing registration data and repairing cars on behalf of all enterprises operating on its territory. If the GR unit responsible for the repair of wagons will not be part of the division performing the functions of the railway administration, then digitalization of interaction with a car repair enterprise becomes a serious and urgent need.

Internal processes for the usage and maintenance of the rolling stock are formalized and supported by information systems.

Decisions related to maintenance of the rolling stock are not automated and are made manually, albeit based on data (specialized system reports).

Recommendations

It is recommended to draw up a formal summary description of all processes associated with the usage and maintenance of the rolling stock (currently formal descriptions are available only for some sub-processes or steps of this process). This description should include data and reports used for making decisions. The creation of such a description will automate at least some of the decisions included in this process.

4.2. IT Branch (World Business Solutions) Operational Processes

4.2.1. Software Development Processes

Current Situation in GR

In the processes of software development, the following characteristics were found:

- Interaction with the customer (other GR units) takes place through vertical subordination. The order for development comes through the director of the business unit (branch). Such interaction prevents the use of agile approaches to software development.
- The development process is based on the Waterfall Method. Although the Waterwall Method allows for easier planning of finances for software development, the main disadvantages of this method are:
    - processes that are not mature in terms of formalization will also be digitized.
    - lack of flexibility - for example, if the project requires more time and financial resources than planned, then the performer is forced to cut resources on the final stages of the project, for example, on testing.
    - it is not possible to change the project in the direction of cost optimization or change the concept or functionality in the course of the project.
    - it is not possible to react to changed conditions in software development during the product creation, as the waterfall method usually involves testing the entire product instead of testing the units of the product.

The use of agile approaches in software development enables organizations to:

- respond more flexibly to changes in processes or at the enterprise that could not have been foreseen before the start of the project;
- respond more flexibly to other new factors that have emerged during the course of the project`s implementation;
- organize project financing in a more flexible manner.

Lack of flexibility in organizing all these aspects of the development process complicates project implementation, as noted during the interview (see, for example, Table 31).

Flexibility in organizing the development process is especially important for GR as an enterprise in constant development, in constant transformation and improvement of its business processes. It is also extremely important in the case when the digitalization of not fully mature processes occurs (or the processes with which this process should interact is immature in the sense of digitalization).

It should be noted that monitoring investment performance requires slightly more complex methodology while using agile development methods. As mentioned in Section 3.3, specific methodologies for assessing the economic impact of investments should be selected during the development of the financing model for the digital transformation.

The examples of the horizontal interaction between business units are related to small-scale amendments and only within the framework of already initiated IT development projects. This can complicate the emergence of new digital initiatives.

Recommendations

The recommendation is to develop a procedure for applying agile development methodology on GR, along with the existing Waterfall methodology, and to choose one of these options at the stage of project initiation, depending on the complexity of the project, the degree of digital maturity of processes and other factors.

Further to the above, it is advisable to introduce the horizontal interaction of business units with IT teams into enterprise management process. The effectiveness of such interactions is highly dependent on the organizational culture and digital skills of employees and therefore can be recommended as a smooth change based on the assessments of branch managers.

4.2.2. Information Security in Software Development and Maintenance

Current Situation in GR

Compliance with information security rules is an important part of the development process, especially when outsourced developers are involved in the development or maintenance. It should be noted that information security is currently supported by a limited number of measures:

- External audit company annually conducts information security checks, but only in selected areas.
- Information security audit is not a mandatory procedure when concluding an outsourcing agreement.
- Device control producers are in use only if the employee uses devices provided by the company. It is allowed to use internal railway information resources with various client programs and devices (incl. personal ones).

- Multi-factor authentication is used only to establish VPN connections but is not used to protect access to information resources, for example, to the corporate e-mail.

Recommendations

Assess the risks associated with the security of information on IT operation processes (partially done) and - especially - during development processes (have not been conducted).

4.2.3. HR Management at the IT Branch

Current Situation

To attract and retain highly qualified workers (in particular, SAP HANA analytics, consultants etc.), the practice of part-time employment is used.

On the one hand, this provides a flexible system of remuneration and use of personnel budget, since such tasks do not amount to full time positions. This practice generally also encourages exchange of experience among professionals.

On the other hand, this practice implies a certain inflexibility in planning the development process, since there is no guarantee of attracting a specialist for the required amount of time and for the time period required by GR.

Recommendations

Given the state of the Georgian labor market, it may be relevant to employ more detailed and possibly long-term planning methods for development projects (including the use of agile methodologies) in order to mitigate the risk of developers lacking sufficient working time resources. More precise planning enables more accurate forecasting of developer work time requirements and the option to amend working contracts with developers in advance, reserving the required amount of developer work time.

4.3. Recommendations for Business and Operational Processes

With regard to the internal processes of the enterprise that are related to the transportation of goods and passengers, a significant effect can be expected from a better usage and presentation of data. The level of development of information systems allows to assume that the quality of data, the speed of their receipt, processing and presentation can be used to support decision-making, and in the case of good formalization of processes – to automate decision-making.

At the same time, the insufficient level of formalization of processes and the imbalance in the development of the related systems does not yet allow making fast progress with digital transformation.

5. Information Technology

The main factors that determine the capabilities and possible speed of enterprise digitalization processes are the available capacities, reliability, safety and development potential of IT infrastructure and technologies.

The information technology (and the related telecommunication technologies) should provide the agreed level of support for all services in portfolio for various users. The term "users" includes not only "external" users such as shippers, consignees, freight forwarders, passenger transport users, but also "internal" users. For example, freight and passenger departments are users of infrastructure, as well as planning and traffic management services.

5.1. Technologies Used in IT Infrastructure

Current Situation in GR

Although GR has not formulated an IT strategy in a single document, the management of the IT department has a clear understanding of the software and hardware technologies serving the processes of the enterprise, development requirements, and the target digital platform of GR.

In terms of GR target digital platform definition, the following facts can be noted:

- The IT infrastructure and hardware components that comprise the target state of the digital platform have been selected (VMware virtual machines, HP and Cisco networking, SAN storage systems);
- Several main software platforms (or basic operating systems) to serve various groups of processes for the target digital platform have been selected (SAP HANA / ABAP, Microsoft servers, Microsoft OS on desktop computers);
- A database solution for the target digital platform has been selected (MS SQL);
- A choice of programming languages for developing the information systems has been defined (C#/Dot Net, NVC, SAP HANA / ABAP).

The risk assessment identified the transfer of information systems to cloud services as being inadvisable. This possibility was considered and ruled out objectively for the following reasons:

- Despite the availability of high-quality Internet, the nearest data centres with a sufficient level of services are located in Germany, posing significant risks to the quality of communication,
- Legal regulations regarding the storage of critical data abroad are not entirely clear.

With this in mind, the target digital platform for GR (with a timeline over the next few years) is based on two of its own data centres. This places high demands on the telecommunications infrastructure, but as of the time of writing this report, these needs had been satisfied.

Recommendations

To begin, establish the above-mentioned desired digital platform as a distinct document that may be discussed inside the organization. The document should include the following:

- An assessment of the prospects for the development and support of the selected components (at first glance, the components listed above seem to be supported, but an accurate analysis should be carried out).
- Estimates on the cost of licenses for software components, including the foreseeable needs related to the increased number of users, systems performance, and number of servers, including redundant servers.
- Assessment of the availability of the necessary software developers.
- Assessment of the labor costs versus the cost of outsourcing services to support the telecommunication systems and hardware maintenance.
- Assessment of the availability of telecommunication systems and hardware maintenance specialists in the field, either in the local labor market (in the case of using own specialists), or proposals from third-party local firms.

In the future, this document should form a part of the IT strategy of the enterprise, but since the IT strategy has not yet been formalized, the description of the target digital platform can be written today as an independent document. It should also be aligned with the business strategy of the enterprise.

5.2. Information System Technologies in Use

Current Situation in GR

The information systems of GR that serve the various internal processes and interaction with users and partners of the GR are:

- Freight transportation system for servicing processes specific to freight rail transportation,
- Passenger transportation system "Orion" for servicing the processes of ticket sales and planning of passenger transportation,
- SAP HANA for servicing more standard internal processes (personnel management, financial management, property management, etc.),
- OLAP CUBE for online analysis of operational data and storage of data archive of information systems for freight and passenger traffic,
- 1C: ITIL for incident management,
- Auxiliary systems for managing the development process and supporting IT systems (Redmine as a development management system and GitHub as a version control system).

The choice of platforms for implementation corresponds to general recommendations and good practices, for example ITIL. Standard customizable solutions are selected to service

standard processes, and self-developed unique software are used exclusively for processes specific and unique to the field of railway transportation. The specific legal situation of GR does not allow servicing the transportation processes, for example with the help of standard ready-to-use European software solutions based on the TAF / TAP TSI.

The strategy for the development of information systems exists only at the level of common understanding and has not been formalized as a document. There is no roadmap adopted for the development of the information systems.

The risks related to the security of network resources and the reliability of the hardware platform are assessed in GR and are consistently mitigated (see section 3.1), but there is no overview of the risks associated with the sharing of information in a secure manner. It is not defined what type of information should be available for managers or employees at the different levels of the organisation. It is not defined what type of information constitutes a commercial secret (during the interviews it was mentioned that the decision on this issue should be done by the Government of Georgia).

Recommendations

In general, advisable is to create an IT strategy for GR. In the absence of a formulated business strategy of the enterprise, the methodology of critical success factors (CSF) can be used to formulate the IT strategy, which will be a logical continuation of the methodology for assessing and reducing operational risks. It will be relatively easy to form and agree on such a CSF list with business structures. CSF for IT development should also be formulated, for example as "increasing the stability of the main processes" and CSF can be supported by IT strategy with rather traditional measures:

- Ensuring the safety and fault tolerance of the technical means (including information systems, applications, and information security tools). Information security issues are also linked to the need to improve the overall digital skills and digital hygiene of the employees.
- Ensuring the safety and fault tolerance of the software.
- If CSF were formulated as "recognizing high risks", then CSF can be supported through the IT strategy by:
    - Creation of BI for a business block suitable for decision support (statistical and operational reporting, flexible analytics with predicate functions) that unites all available types of information from all information systems,
    - Stability of the main business processes can be supported with further initiatives (for example, more active exchange of experience, using best practices of other railway infrastructure managers).

The single information warehouse that could store data from all information systems and provide analytics for all this data implies high and specific requirements for the database. The design of such a warehouse is highly likely to change the choice of technologies for the target digital platform. We can recommend using NoSQL databases (for example, Azure Cosmos DB, or the Apache Ignite /CouchDB/Giraph product family) for storing heterogeneous (including unstructured or differently structured) data. Also, in order to support the digital transformation

of the enterprise, the IT department must be proactive and propose new technologies for the business units:

- Automation of data collection, introduction of the Internet of things, Machine Vision, etc.,
- Introduction of unmanned technologies, where their application is technically possible.

Due to the high cost of licenses, the information from the SAP HANA application is provided to the process managers only once a day. It should be analysed if the managers need the information in real time or if cost efficiency is more relevant in this situation.

5.3. IT Operation Processes

The following main processes were examined as parts of IT operations processes: incident and problem management, facilities management and access management.

5.3.1. Incident and Problem Management

Current situation in GR

Processes related to incident management and problem management in GRs are well formalized and digitalized (at least in terms of incidents and IT problems). The process takes place using the information system 1C:ITIL (see Table 24).

On the other hand, the information system is used solely to support the process and to assess the quality of the user support service (SLA), but this data is not studied in further detail, for example, to identify risks or make process changes.

Recommendations

It is essential to use the same data to assess risks in the management of IT incidents and problems. Also, based on the best practices and based on the principle of "using data for management", it is possible to recommend the digitalization of incident management for all processes in the GR, not just limited to the IT area. This is likely to require the introduction of more versatile incident management products. A single system would allow to unify and automate the reporting of incidents throughout the enterprise and to use it in both for automatic maintenance of GR management in terms of reporting, and for assessing the risks associated with the operational activities of the entire enterprise.

5.3.2. Facilities Management

The process of IT facilities managing as well as incident and problem management is also implemented mainly within the 1C: ITIL information system (see Table 24).

Risks associated with the continuity of IT service delivery have been identified and steps have been taken to mitigate them. On the GR, two data centres are organized, physically located in different places. The time for complete switching from one centre to another is 30 minutes (see Table 8).

Recommendations

It is recommended to conduct an assessment of the risks associated with the security of the information during operation (partially done) and - especially - during development (not available).

5.3.3. Access Management

Current Situation in GR

Access control is carried out on the basis of uniform policies managed centrally. Information security risks arising from compromising the authentication of local network resources have been eliminated (see Table 8). Access control outside the GR computer network is mainly provided by a closed network with limited access (see Table 9).

Based on the information of (see Table 32), the ability to use corporate IT services using devices that are not controlled by the company can be recognized as security risk.

Recommendations

It is recommended to assess the aforementioned risk and identify those IT services that can be used from devices not controlled by the company without compromising information security. The use of other IT services using such devices should be restricted and prohibited.

6. Other Technologies in Use

In this section, railway-specific technologies and systems will be considered with the promise of digitalization and process automation, as well as a significant potential as a source of data that are important for the optimization and automation of other processes.

6.1. Technologies Used in Traffic Control

Current Situation in GR

The signalling and blocking systems used in GR are not centralized. The existing equipment provides a sufficient level of reliability in traffic control, although it does not allow centralizing the process (it is also not possible to automate this process without significant technological modernization; such modernization would require significant investments and cannot be carried out quickly).

Some types of equipment are already now providing a significant amount of information that is used ineffectively. For instance, GPS devices installed on locomotives provide the ability to visualize the position of trains on the map. Nevertheless, this data is not used for other purposes (analysis). Information about the fact of the departure or arrival of the train is entered manually by GR employees (for example, information from small stations is first transmitted by telephone or radio to operators, who then register it in the information systems). Such a process involves the risk of errors (human factor) and delays in the flow of information.

Recommendations

We recommend a wider use of information from GPS devices and allowing other information systems access such information (after some preliminary processing), which can 1) optimize the information input processes and 2) provide data for decision support systems. It would also provide the analytical system (BI) with a large amount of data for various studies (for example, on the rational use of locomotives when moving between stations and within stations).

6.2. Technologies Used in Infrastructure Maintenance

Current Situation in GR

In the maintenance processes of a group of signalling and interlocking devices, their life cycle is currently planned solely on the basis of their service life or the fact of failure. At the same time, maintenance or replacement procedures for these devices cause an interruption of the main infrastructure service (interruption or restriction of traffic in the infrastructure section) and, thus, have a significant negative impact on the quality of the infrastructure service and complicate traffic regulation in general.

Recommendations

Based on the best practices of railway infrastructure managers, it is recommended to analyse how it would be possible to optimize the lifecycle of GR devices. Collecting information on the state of devices, as well as existing digital methodologies for assessing the wear of tracks and turnouts can significantly optimize and reduce the cost of the life cycle of devices.

The specific solution to this problem is largely individual (although there are a significant number of descriptions of the methodology, as an example can be mentioned a Finnish Railway methodology description). Therefore, as a first step, we recommend an analysis of the possible information collected (based on the devices used), the applicability of existing digital models to the assessment of devices (including based on the requirements of laws) and then the digitalization of such a process, for example, as part of an SAP, which is suitable for such purposes.

In addition, the collection and export of such information to the analytical system (BI) will provide management with high-quality, objective, and timely information about the current state of the infrastructure, which is an aid in making decisions on planning repairs, planning changes in traffic, and in a strategic sense - in finance planning.

7. Organizational Culture and Personnel

7.1. Railway-specific Personnel Skills

The risk of shortage of personnel with specific knowledge and skills can be recognized as significant, as there is a shortage of skilled personnel in the Georgian labor market. This applies to both railway-specific occupational skills and digital skills of the new employees. To reduce the risks of shortage of personnel, GR in cooperation with the Ministry of Education and Science of Georgia, the Georgian Technical University and DB E&C, a subsidiary of the

German Railways, launched the College of Railway Transport. This institution trains students based on a dual teaching method (learning in parallel with obtaining skills in a real work environment). The College of Railway Transport provides employees with railway-specific knowledge and offers training in the main specialties (railway construction, wagon housekeeping, railway power supply, railway rolling stock, railway signalling, centralization and rail transport) since 2015. The evaluation of the College's volume and quality of the curriculum goes beyond the scope of this assessment; however, it can be noted that the GR's demand for professionals is higher than the available supply.

7.2. Digital Skills of Employees

The rapid development of digital technologies requires the employees to possess skills needed to use the new tools. For the organisation, the main risk of failure in digital transformation processes is related to a shortage of personnel with the necessary computer skills, as well as analytical skills and abstract thinking skills (digital thinking). Despite the confident and stable support of GR leadership, digitalization and even more so digital transformation does not find support among workers at all levels. This is largely due to the low average level of digital skills among ordinary employees of GR.

The following factors constitute risks for building digital capabilities of the employees:

- high degree of uniqueness of the skills and knowledge of key specialists,
- relatively high average age of key specialists in railway-specific areas,
- low level of formalization of unique processes (processes specific to the railway area),
- relatively low level of involvement of key business division in the digitalization processes.

The labor market in Georgia offers only basic digital skills (Microsoft Office and Windows). It is quite difficult to recruit specialists with high-level digital skills in the departments involved in organizing freight and passenger transport, as well as organizing infrastructure maintenance processes. In-house digital skills training is vital for GR. Therefore, an on-the-job training strategy has been developed. The requirements for digital skills of the employees are reviewed every two years and, if needed, the training courses are revised. The training takes place mainly during the employees' trial period. GR also provides additional individual digital skills training for employees, in accordance with their work needs. Such training takes place regularly.

GR rarely outsources ICT training to the market as an "external" service. This can create a risk of not incorporating the knowledge of new technologies into the in-house curriculums. Also, it can be noted that GR does not provide training in the field of in digital security and cyber hygiene. This can be identified as a risk for digitizing the processes and for the company as a whole. According to the company's self-assessment, the target level of digital skills of GR employees (those positions that require working on a computer) has been reached.

7.3. Organizational Culture

Despite the fact that the assessment of the organizational culture is not directly included in the scope of this study, based on the interviews, the following factors of the current state can be noted:

- a high level of knowledge and skills of employees (at least in key positions in the digital transformation process),
- a high level of employee loyalty to the company, at least in key positions,
- a high level of personal responsibility and initiative of key employees, as well as employees directly related to teams implementing digital solutions and technologies.

These factors enable the enterprise to function effectively in conditions even when the economic situation of the enterprise does not allow offering particularly high wages to digital transformation specialists.

7.4. Recommendations for Building Digital Capacities

To improve the employees' digital capacities, GR should invest in retraining and continuing education programs and start to think about the company as a technology business.

The urgent problem of organizational and psychological barriers can be solved by introducing the role of digital ambassadors in the departments, as well as creating and maintaining a culture of constant experimentation and business risk readiness.

Such a strategy will allow the next step in the development of personnel in the company - personnel with significantly advanced digital skills. These employees are confident and comfortable using technology to communicate, search for information, and complete tasks. Because their digital skills exceed the minimum required for current tasks, such employees have the potential to grow, to propose digital initiatives and participate in teams and projects that go beyond their immediate current job responsibilities.

This, in turn, will provide opportunities for modernization of management processes in the company.

We recommended supporting exchange of experience on digitalization between different teams, for which it would be necessary to develop a common language and structure. Also, in order to benefit from such exchange of experience, it is necessary to establish a certain level of abstraction in such messages.

The sharing of experience helps teams to identify opportunities that they themselves have not used, but other teams have. In addition, a common language allows mutually evaluating whether these capabilities are useful and how to develop them.

To mitigate the risks associated with data security and security of business processes associated with access to data, cyber security training should be conducted among GR employees (if needed, executed by external experts).

8. Digital Maturity of GR

Based on the methodology of the assessment, the overall digital maturity of GR is assessed as between "Pre-Digital" and "Digitally Reactive". In the table below, the green colour indicates the position of the GR in the matrix. Light green indicates those achievements that are not yet fully achieved or are partially implemented.

Table 1. Digital Maturity of GR

		Expected Growth of Productivity and Effectiveness				
		Digital Maturity Stages				
		Pre-Digital	Digitally Reactive	Digitally Purposeful	Digitally Optimized	Digitally Strategic
Assessment Categories	Digital Strategy	Ad hoc IT planning	Somewhat clear IT priorities	Documented IT strategy / roadmap, flexible budgeting rules	Strategy alignment of IT	Business strategy is digital-led
	Data Intelligence	Excel / default reports	Customized reports	BI dashboard is in daily use. Managerial decisions are backed up by links to open reports	Prescriptive analytics	Artificial intelligence-based
	Digital Skills/ HR strategy	Minimal essential skills	Reactive to needs	Significantly advanced digital skills	Proficient	Specialized
	IT Processes	Manual systems	Siloed ERP/CRM/ HRMS systems	Basic automation and integrations	Advanced automation	Robotic process automation
	Customer Experience	Limited Customer KPIs	Proactive about getting customer feedback	Customer lifecycle programs	Customer Experience core of business strategy	Enterprise is customer-centred in all its activities
	Risks & Compliance	Responsive to problems	Alert to potential issues	Preventing or limiting impact	Anticipate and avoid, proactively processes changing	Self-healing AI solution

Color coding in **Table 1**.

	GR is on this level of digital maturity
	Some of the characteristic of this stage of digital maturity are present in GR

Below is the description of the digital maturity levels and suggestions for improvements (moving to next level of the maturity).

8.1 Digital Strategy

On this maturity level decisions about digital strategy are made entirely spontaneously, based on responsiveness. Although in certain areas of business there is already an understanding of the development priorities of certain areas and projects of digitalization, this understanding is not systematized. There is a lack of a strategy and roadmap for IT development, as well as tools for assessing the success of digital initiatives. This defines the current level of digital maturity in this category as predominantly "pre-digital".

In order to develop its digital capacity, organizations should strategically map the digitalization paths. The most logical and easy-to-implement practical step at this stage of digital maturity is the identification of critical success factors. This process helps to better understand every important point of contact between enterprise services and customers (both internal and external). The organization can then start to make proactive improvements.

Following the definition of the FSC and the prioritization of development projects, the next step to increase the maturity level, should be to form a digitalization strategy for the company. Such a strategy should also include a financial model to assess the economic impact of digitalization initiatives. If such a model is introduced, more flexible project budgeting will be possible. In particular, to the full use of agile software development techniques will become possible.

8.2 Data Intelligence

Several systems have been implemented for storing data from internal operations and from external consumers. The value of data has yet to be recognized at all levels of management inside the organization and used in an optimal way for the organization.

However, there is a general understanding across the organization that data is valuable and can evolve into actions that positively impact the digital strategy of the organization. However, there is room for a more streamlined approach to leverage data to its fullest in the interests of the business.

This defines the digital maturity level of this category mainly as "Digitally Reactive". Despite the fact that the BI solution has been developed, it is not permanently implemented, ie it is not implemented on a daily and permanent basis to confirm and support the decisions of managers at all levels.

Analysing the data as an aggregate integrity will help determine trends and needs of both the business units of the enterprise and the customers of the services. Understanding this data will also help to form the backbone of the digital strategy of the organisation.

8.3 Digital Skills and HR Strategy

Based on the information in Chapter 7, the level of digital maturity of the GR in this category can be assessed as "Digitally Reactive".

The strategy of ensuring the minimum digital skills required for a given workplace significantly limits both the flexibility of the redeployment of employees within the company structure and

the participation of employees in cross-structural digitalization projects. It also limits employee initiative in proposing business process improvements through digitalization.

The successful implementation of digital initiatives usually requires a significant change in corporate culture. Instead of demanding top-down initiatives and focusing on the vertically managed structure of the company, the management needs to encourage the employees to participate more actively in horizontal integration projects and cross-structure processes. This can be achieved, among other things, by enabling them to play a more active role in generating ideas, by implementing as simple internal buy-in processes as possible, and by providing a flexible work environment in which everyone can interact in cross-functional teams. At the same time, comprehensive training programs will help to improve the overall digital skills of employees and introduce new paradigms of work, including a culture where it is acceptable to make mistakes.

8.4 IT Processes

ERP/CRM/HRMS systems have been introduced and applied on the GR on a permanent basis. At the same time, the processes control subsystem is rather poorly integrated with the systems serving the main business processes. Some SAP modules receive data from transportation management systems, but this data does not affect the business process. Also, the data is transferred to the BI system, but only for the purpose of presenting reports for managers of various levels; these data are not used to automate decision-making.

Based on this, the level of digital maturity of GR in this category can be assessed as "Digitally Reactive".

To become more efficient, the organization should start automating these processes that are digitized and formalized at a good level. The processes selected should be the ones that have been stable for a longer period of time.

Automation of tasks ensures greater stability of processes, eliminates the influence of the human factor, and makes processes more transparent. Also, automation increases the speed of processes, including the speed of decision-making. In addition, the automation of routine processes frees up time for employees to work on other tasks.

The next step is to create a process catalogue and after that discuss the possibilities of process integration. The purpose of such a discussion is to create digital models of activity areas of the enterprise. Ultimately, such digital models can be used in predictive comprehensive analysis of the possible impacts from various external and internal factors. It could lead to development of new products.

More strategic steps to improve the efficiency of processes requires not only organizational measures, but also the use of new technological solutions. To improve the efficiency of operational activities and propose new possibilities for processes automation, it is necessary to introduce new technologies, such as machine vision, machine learning, Internet of things, big data, etc.

8.5 Customer Experience

While the company has an understanding of customers and their expectations, those beliefs are largely based on the unique informal knowledges of experienced managers of GR. Collecting and organizing information about user experience is not digitalized, this does not allow predicting (at least predicting based on data) the reactions of users and customers.

Improving the overall quality of customer service is not seen today as a digitalization or digital transformation challenge.

This gives an assessment of the digital maturity of GR in this category as "Pre-Digital".

The next step in this area should not be about reaction-based decision making, but about actively developing a strategy to reduce customer complaints and increasing the overall level of satisfaction with the service by predicting, preferably automatically, customer responses based on the customer experience data collected.

The most obvious way to improve customer experience is to get more customer feedback as every client interaction provides an opportunity to learn and improve. To form a better understanding with customers and improve the quality of interaction with them, it is not enough to use classic CRM systems. Customer experience management systems should be applied that are higher-end solutions (for example, analysis of relevant social media data) and require new competencies and technologies.

8.6 Risks & Compliance

Risks associated with IT are partially detected (mainly in terms of the security of networks, security of information resources and the stability of the infrastructure) and mitigated or eliminated but are not fully recognized in terms of information security. Risk assessments in the area of software development were also not submitted, and risks in the area of operation of IT infrastructure were only partially assessed (although the task of ensuring the continuity of information services itself has been identified and is being solved).

Thus, the risk management model in GR can be predominantly described as "responding to most visible problems" with partial prediction of risks based on the knowledge of experienced employees but not on data. In principle, the position of the GR in this category can be assessed as "Pre-Digital".

There are some information security policies and procedures formalized, but the involvement of external experts (IT security company) could help to improve the quality of these documentation and also help to train relevant employees on information security.

A digitally driven organization should think more about service continuity and existing processes that can be rebuilt easily and quickly when difficulties arise. In addition, the use of digital technologies to assist in data-driven decision making and in the automation of processes results in a significant reduction in the risks of service continuity.

The creation of digital models of processes using data from various sources for predictive functions also reduces risks for the core business, as it allows quickly getting options for reconfiguring business processes by modelling the influence of various factors.

Table 35. Data on the number of employees on railways of European states with comparable lengths of served lines and traffic volumes. *Data for 2020 is given unless otherwise specified.*

State	Operating performance in 2020			Numbers of employees in enterprises (in case these are separate enterprises) or branches or departments (in the case of a single enterprise or holding structure)			
	Length of lines, km	Freight traffic volumes, mln. tn.	Passen-gers carried, mln.	infrastructure management	freight trans-portation	passenger transport-tation	IT-related structures
Georgian Railway	1612	10,8 (prognosed 12 in 2021)	3	1166 (2121)	5192 (2021)	4832 (2021)	
Lithuanian Railway	1869	53,4	3,34	3100	3224	2700	about 200[3]
Latvian Railway	1897	24,1	12,9	6265	3685		about 180[3]
Estonian Railway	1214	13,2	7,11	698	688 (leading railway undertaker[1])	322 (leading railway undertaker[2])	about 45[3]
Slovakian Railways	3629	26,2	46,7 (77,3 in 2019)	13623	5371 (leading railway under-taker)	5910 (leading railway undertaker)	about 520[3]

[1] The number of employees of other carriers is 20-40. This number is not added to the total headcount of freight railway undertakers as these smaller undertakers operate both freight and passenger transportation.

[2] The number of employees of other carriers is 18-20. This number is not added to the total headcount of passenger railway undertakers as these smaller undertakers operate both freight and passenger transportation.

[3] The total number of employees of structures directly related to the IT field in the enterprises of the infrastructure manager, the main cargo railway undertaker and the main passenger railway undertaker. Due to the differences in the structures of different enterprises, the approximate number of employees directly related to the development and operation of information systems, IT facilities and information security are given.

Annex 3: Recommendations for Organizational Set-up

In the organization set-up strategy, when planning the structure of the enterprise and the distribution of functions between departments (which defines internal processes), the forthcoming changes in legislation affecting the regulation of railway transport in Georgia should be considered.

An important point in the organization of interaction between departments (internal processes) within the enterprise is the connection with the described processes. This is especially true for the processes associated with the main services of the enterprise.

Accurate recommendations require careful analysis and familiarization with the specific aspects of Georgian legislation. However, based on the example of other railway enterprises that have gone the way of separating the infrastructure manager (IM) and the railway undertaker (RU), the following recommendations can be made:

RU is a person who organizes and carries out transportation in the form of trains moving between railway stations. This is a European understanding of the functions of a RU, which is somewhat different from the understanding that is accepted, for example, in Russia or in Kazakhstan (where a freight RU is narrower and closer in function to the concept of a freight forwarder). The RU may or may not be the owner of the locomotives. Thus, the RU serves the following processes on the part of the shipper or consignee:

- Order for transportation.
- Provision of the planned transportation by wagons.
- Provision of loading in accordance with the rules of transportation, execution of the transportation documents, formation of the trains and their movement (under the management of the infrastructure manager).
- Usually, the functions of the carrier also include interaction with state authorities regulating the crossing of state borders and, accordingly, ensuring that all the necessary documents are available.

On the part of IM, the RU serves the following processes:

- Ordering infrastructure bandwidth to carry the required number of trains and goods. In case of long-term planning, this affects the main traffic schedule, from where the RU reserves a part of the capacity on certain sections of the infrastructure for a long period (for example, two trains per day during the year). In short-term planning, this is usually a request to use unallocated bandwidth in the form of a "Short-Term Path Request".
- Providing transportation with rolling stock (wagons and locomotives) that meet the requirements of the IM; locomotive drivers are usually also licensed by the IM.

The IM is obliged to maintain the infrastructure in a condition not lower than the guaranteed one, as well as to organize the movement of trains along its infrastructure. Also, the sphere of IM usually includes responsibility for the safety of transportation along the infrastructure. This means the following large processes:

- Planning and distribution of bandwidths.
- Planning and implementation of the necessary measures to maintain the infrastructure in a given condition (this task is somewhat more difficult than on highways, since there are often no options for bypassing the section being repaired, and therefore such measures cause interruption of the main infrastructure service and require careful planning),
- Regulation of train traffic on infrastructure,
- Ensuring traffic safety usually comes down to ensuring the reliability of systems responsible for traffic regulation (signalling and blocking systems),
- Ensuring the safety of transportation, i.e. the need for the monitoring over the transported goods by the IM. The scope of such control is determined usually by national legislation.

Georgia's presence in several legal areas at the same time complicates the situation somewhat. For example, according to the SMGS rules (OSJD regulation, which is harmonized with the European legal framework), the RU transfers the train, wagons, and cargo to the next carrier. From the point of view of the Railway Council, at the border, train, wagons, and goods are transferred from one railway administration to another railway administration. This leads to some difficulty in describing the processes of transmission and reception of trains, wagons, and cargo at the border. On the one hand, the actions, for example, when receiving a train, must be divided among several roles. On the other hand, if the train contains wagons belonging to several carriers, then RA is obliged to ensure the maximum independence of the RUs, as well as the preservation of commercial secrets that are in the transportation documents (these paper documents are transferred with the train in the form of a single package, they are also transferred in a single stream if they exist in form of digitalized messages).

At the same time the concept of a railway administration (RA) means a representative of the state that regulates the planning functions, operational interaction at border crossings, accounting for wagons and settlements in international traffic in Council of Railway Transport juridical field. Typically, in the member states of the Council of Railway Transport, such functions are owned or delegated to largest IM (usually owned by state). This situation is further reinforced by the consideration that the functions of the RA should be carried out in favor of all RU of a given country equally, which means that they should be delegated to an independent person.

Proceeding from this approach, the IM in the member countries of the Council on Railway Transport usually bears the responsibilities of the RA. Such obligations include:

- Planning of international transportation (in part of communication with abroad partners).
- Reception and transfer of trains and rolling stock at the border (the transfer of goods is regulated by the Council for Rail Transport to a lesser extent).

- Payments for the use of wagons (for example, in case of loss of a wagon, the culprit railway administration pays for the damage without any additional conditions), and some others.

These functions and obligations are in good harmony with the duty of ensuring fair competition between the consumers of the infrastructure service, which, as a rule, is also imposed on them by the state. In the case of Georgia, there is no such obligation declared yet, for the reason that competitive RUs have not yet emerged.

All in all, the role of the RA expands the functions of IM and requires the performance of the role of a representative to the partners in the transportation process abroad. If we consider information flows, then IM playing the role of RA works as a kind of an information hub. He must integrate information from the local RUs, sending it to overseas participants in the transport. In the opposite direction the task is more difficult: the RA must provide sufficient information to all participants in the transportation process in order to guarantee the preservation of trade secrets from competing transportation process participants (for example, correctly divide information between competing RUs or freight forwarders).

Annex 4: Recommendations According to Digital Transformation Financing Model

Table 36. Table 1 - Integral economic indicators of the digital transformation strategy

Economic indicator	Unit of measurement	2022	…
Decrease (change) in operating costs	mln. lari		
Decrease (change) in capital costs	mln. lari		
Increase (change) in revenue	mln. lari		
Investment in a digital transformation strategy	mln. lari		

Table 37. Sources of funding for initiatives and activities of the strategy

Economic indicator	Unit of measurement	2022	…
Investment in digital transformation strategy activities	mln. lari		
Including from sources:			
- Own and credit funds of the company	mln. lari		
- Bank loan for the purpose of digital transformation on market conditions	mln. lari		
- Concessional loans and loans for digital transformation purposes	mln. lari		
- Means of digital solution providers and other counterparties in digital transformation	mln. lari		
- Non-state trust funds	mln. lari		
- State trust funds	mln. lari		
- State subsidies	mln. lari		
- Project financing from the state	mln. lari		
- Government funding from other sources	mln. lari		
- Funding from other non-governmental sources	mln. lari		