A Comprehensive View of Intelligent Transport Systems and Supply Chain Management for CIS Countries

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Abstract: The application of Intelligent Transportation Systems (ITS) has continued to revolutionize contemporary Supply Chain Management (SCM). Operators leverage real-time information about vehicle conditions and traffic to improve the overall transport systems through Global Positioning System data, among other avenues. Such systems have been invaluable in commercial vehicle administrative processes, vehicle clearance, automated roadside safety inspection, hazardous materials incident reporting, and commercial fleet administration and management. Using a sample of 500 respondents, the study used a mixed method design to understand the key challenges faced by the intelligent transport systems and supply chain management processes in the Commonwealth of Independent States countries. The study realized that concerns about security of goods, threats from external attacks, and transportation problems are key concerns among users. The study finds a statistically significant association between cases of loss of goods and the SCM applications rating, but no statistically significant association between the cases of loss of goods and the type of goods and the type of goods delivered. Infrastructural development of countries provides comparative advantages in the use of ITS systems. Future studies should attempt to use comprehensive data.

1 INTRODUCTION

Revamping contemporary supply chain management has been one of the integral ways of improving efficiency in multimodal transportation systems. Marrota et al. (2018) understands global supply chain management (SCM) through Dornier's Four Forces Model: global market forces, global cost forces, political and macroeconomic factors, and technological forces. The latter—technological forces—has continued to redefine contemporary logistics. Kelarestaghi et al. (2019) believe that efficient management of multimodal logistics would be inherently difficult to achieve without the use of sophisticated information and communication technology. The use of intelligent transportation systems has been specifically highlighted for its role in increasing operational efficiency of the SCM. Veres, Bányai, and Illés (2017) designated intelligent transportation systems (ITS) systems in the domain of GIS technology and underscore its role in optimizing the supply chain. For Veres et al. (2017) the application of advanced technologies such as the Advanced Traveler information system (ATIS) and Advanced Drive Assistance Systems (ADAS) have optimized SCM systems, minimizing the overall costs such as the consumption of fossil-based fuels.

Intelligent transportation systems can be applied in all the modes of transportation—air, ship, rail, and road, and to every element of the transport system. The primary function of ITS is to support network controllers and other users (citizens, companies and even governments) in decision-making processes (Mangiaracina et al., 2017), leveraging accurate real-time information on traffic and vehicle conditions. Consequently, ITS improves the overall transportation systems. However, much of the research on ITS has focused on developed countries in the west (UNECE, 2017). Other countries, including the CIS countries, have also continued to leverage the benefits provided by smart SCM systems. However, such systems are not without challenges that can jeopardize operational efficiency and consistency.

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In our study, our main objective is to understand the key challenges faced by the intelligent transport system and the supply chain management process in CIS countries which may be helpful for further studies.

2 LITERATURE REVIEW

2.1 Overview of the CIS Countries

The Commonwealth of Independent States were formed out of the USSR in 1991 and include Armenia, Belarus, Azerbaijan, Kirghizstan, Kazakhstan, Moldavia, Tajikistan, Uzbekistan, Russia, Ukraine and Turkmenistan. In international supply chains (ISCs), the CIS region has been a natural transportation and logistics intermediary between the European Union and the Asia Pacific region—two centers of international economics. For a number of countries in the CIS region, especially countries having access to seas, international transportation systems can act as a crucial link to sustainable economic development. However, logistics in the CIS region currently lags behind (with annual estimates at US$80-90 bn), of which US$50-60bn is accounted by Russia, and US$20-30bn mostly shared by Ukraine and Kazakhstan (United Nations Economic Commission for Europe, 2017). These countries have different strengths in terms of their GDPs, but most have still managed to come up with excellent transport systems that have improved their supply chain management processes.

2.2 Intelligent Transport System

The applicability of Intelligent transportation system (ITS) has attracted interest both from users and academia as such systems improve traffic management and general road safety (Tundrea et al., 2017). One technology that has been developed with regards to ITS is the vehicular ad hoc networks commonly referred to as VANETs. The VANETs allows vehicles to share information about traffic along various routes which can enable other road users to avoid congested routes and improve efficiency (Badalyan et al., 2014). However, the virtue of this system being wireless presents with it a number of challenges specially to do with cyber-attacks as there have been security and privacy concern of such communication systems. Certificate revocation, confidentiality, anonymity, authentication, identity privacy, location privacy among other privacy issues have been the main concern of the intelligent transport systems. Owing to the fact that sometimes the goods being transported along roads and railways tend to be sensitive and sometimes very valuable, the dangers of malicious attacks and acess abound (Traganos et al., 2015). The insurance companies are also not spared as they end up spending a lot in terms of compensation. There are however new developments in this area as solutions to this problem are being discovered through aspects like scalability and latency (Novikov et al., 2017).

2.3 Supply Chain Management in CIS Countries

The concept of logistics has gone through a number of evolution processes and currently it is used to mean much more than just the action of physical transfer of goods. There are a lot of players that are involved in the whole logistics processes including commercial banks, custom brokers, insurance companies, suppliers and freight forwarders. All these players in the logistics industry show a need of having not just a well-organized logistic model but also a robust supply chain management that keeps all these players into consideration (Silvestre, 2015). This is because a problem in one of these players may end up paralyzing the whole SCM process. For instance, failure of a financial institution to release money on time to pay for the many expenses that are incurred along the transportation chain would hinder the goods from reaching their intended destination conveniently and on time which may lead to unprecedented losses (Sharipbekova & Raimbekov, 2018).

2.4 Gaps in the Supply Chain

The supply chain management is affected by multiple factors, key being the uncertainty of product prices and availability owing to the fluctuating demand and supply trends in the market. This complexity creates a gap in any SCM system that can be developed as this unpredictability is hard to foretell. Equally, the fact that producers and manufacturers are now preferring to do manufacturing and production close to where there are factors of production like raw materials and labor has brought gaps in the SCM systems since a problem in one region of the world can bring about problems in the whole SCM system (Swami & Shah, 2013). For example, when there is a crisis in an area where raw materials are obtained, it becomes problematic to get the products in any part of the world and this creates a gap in the whole of supply chain management process (Radosevic, 2011). This problem has been so rampant especially at the wake of Covid-19 where some countries have been unable to do the testing of the virus owing to the raw materials like the reagents that are used in the testing which became problematic to come across due to their high demand all over the world.

3 METHODOLOGY

3.1 Participants

The research which was a mix of both qualitative and quantitative methods entailed a study of 500 people who are engaged in various forms of supply chain management and cargo transportation business, including cargo transporters and clients. Respondents are homogenous in terms of sex, between 15 – 64 years old. Other segmentation variables were not taken in consideration. The clients included people who have at one point ordered goods that were supposed to be transported from any of the CIS countries and sought to establish the complexities that were found in the whole of the supply chain model. The key research question was "what are the key challenges faced by the intelligent transport system and the supply chain management process in CIS countries?"

Two questionnaires were used to obtain data, one being for the users of SCM and another one for the providers. An online link was went to respondents in order to create the data set.

3.2 Hypotheses

Out of the research question, three hypotheses were formulated as listed below:

1. SCM applications play a key role in ensuring there is security and privacy of the transported products.
2. The transport infrastructural development of the respective CIS countries plays a key role in determining the success of SCM systems.
3. Cargo tracking systems and technology has a key role in determining the confidence and success of the SCM processes.

4 RESULTS

This section provides the results of the study. Survey questions are shown in the appendix section. Both descriptive and inferential analysis are provided;

4.1 Security and Privacy Concerns

Both the providers and users cited various cases of security concerns and privacy challenges in the current systems that are in use. There were various mentions by users of instances where their goods were lost along the way and the same challenge was recorded by the providers. For instance, 24% recorded to have always encountered cases of loss of goods on transit while 75.51% recorded that they rarely encounter such cases. Privacy of essential goods that are mostly valuable was also listed as a key challenge.

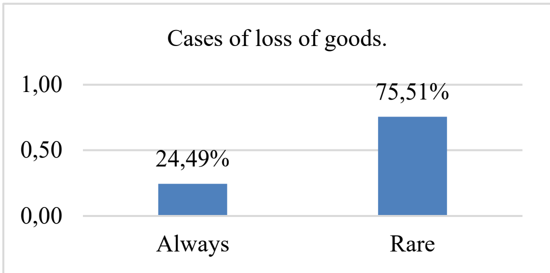

Figure 1: Cases of loss of goods.

4.2 Tracking Systems

The need of having robust and modernized transport system was established to be a key requirement in a bid to making the supply chain management systems safer and effective. Users noted that the knowledge of the freight company or the truck doing the transportation having a tracking system gives them confidence to use it and the assurance that their products will arrive safely and that they would be able to track the movement from the origin of their goods to the destination. For instance, 71% of providers recorded that they use cargo tracking services while 29% were not using.

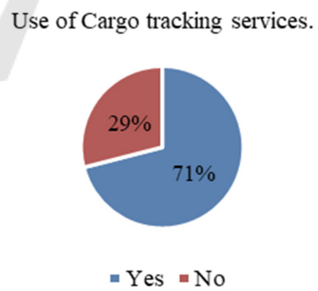

Figure 2: Use of Cargo tracking services.

A cross-tabulation was further conducted to understand any correlation between the use of tracking services and the types of goods. The analysis indicates that tracking services are mostly used with solid goods than perishable goods.

Table 1: Use of Cargo tracking services * Types of goods delivered Crosstabulation.

Count

		Types of goods delivered		Total
		Perishable goods	Solid goods	
Use of Cargo tracking services	Yes	121	227	348
	No	52	100	152
Total		173	327	500

4.3 Infrastructure Role in SCM Systems

It was also established that infrastructure plays a key role in determining the success of a particular SCM system. Providers noted that they have had many cases of transportation problems due to poor infrastructure with 67% recording that they have at one point or another encountered transportation problem and 33% noting that they have never encountered any problem. Countries that had records of low or poor infrastructures also recorded having key challenges in their supply chain management systems and processes while countries that have improved infrastructure recorded key successes in SCM especially when it came to the score of loss of goods and success of SCM applications.

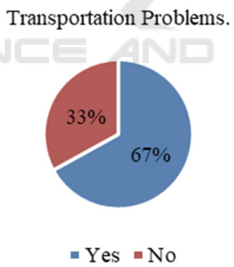

Figure 3: Transportation Problems.

In cases where transportation problems were reported, there were higher instances of reported losses of goods as shown I the cross-tabulation provided below;

Table 2: Cases of Loss of goods * Transportation problems Crosstabulation.

Count

		Transportation problems		Total
		Yes	No	
Cases of Loss of goods	Always	107	61	168
	Rare	224	108	332
Total		331	169	500

Inferential analysis.

An inferential analysis was conducted to understand the association between the attributes.

Ho: There is no significant association between loss of goods and types of goods.

As shown below, p=0.243, thus the study realized that there is no significant association between the cases of loss of goods and the type of goods delivered.

Table 3: ANOVA[a].

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.305	1	.305	1.364	.243[b]
	Residual	111.247	498	.223		
	Total	111.552	499			

a. Dependent Variable: Cases of Loss of goods.
b. Predictors: (Constant), Types of goods delivered.

Ho: there is no statistically significant association between cases of loss of goods and the SCM applications rating

In the analysis, p=0.001; p<0.05, thus the study finds a statistically significant association between cases of loss of goods and the SCM applications rating.

Table 4: ANOVA[a].

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.861	1	4.861	22.691	.001[b]
	Residual	106.691	498	.214		
	Total	111.552	499			

a. Dependent Variable: Cases of Loss of goods.
b. Predictors: (Constant), SCM Applications rating.

5 DISCUSSION

The results section provides critical perspectives on customer evaluation of ITS systems. For instance, there is generally a marked improvement in the line of cargo tracking and most freight companies have now embraced ITS technologies. There is, however, a need of having SCM applications that guarantee users of safety and privacy of their goods. While users would most likely want information about the location of their goods and services, safety is indicated as a core concern for many of the users of such systems. For instance, further inferential analysis indicates a statistically significant association between cases of loss of goods and SCM applications rating (p=0.001; p<0.05). This is an indication that while many systems have been implemented in ITS systems, the security levels of such SCM applications are an issue among users.

Table 5: ANOVA[a].

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	4.861	1	4.861	22.691	.001[b]
1	Residual	106.691	498	.214		
	Total	111.552	499			

a. Dependent Variable: Cases of Loss of goods.
b. Predictors: (Constant), SCM Applications rating.

Our findings about security concerns about ITS systems have further been explored in other studies and similar findings indicated. For instance, Kelarestaghi et al. (2019) indicated that users often have concerns about the susceptibility of the systems to malicious attacks and cybersecurity threats. Unknown security vulnerabilities have trigged a race among adversaries to find weakness of such systems. Harvey et al. (2020) affirm that security is an issue among users of ITS system. as such, there is a need to introduce solutions aimed at addressing the vulnerabilities of such systems to overcome external threats and reduce risks of attacks.

Additionally, the study finds no association between the cause of loss of goods and the types of goods delivered. In the statistical analysis below, there is no statistically significant association between the cases of loss of goods and the types of goods delivered ($p=0.243$; $p>0.05$). Anholcer, Hinc, and Kawa (2018) believe that smart supply chains need to be immune against loss of goods on transit. For the authors (Anholcer et al., 2018) designing smart supply network systems with decision support systems (DSS) can reduce losses and multiple deliveries.

Table 6: ANOVA[a].

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	.305	1	.305	1.364	.243[b]
1	Residual	111.247	498	.223		
	Total	111.552	499			

a. Dependent Variable: Cases of Loss of goods.
b. Predictors: (Constant), Types of goods delivered.

The analysis further indicated that the economic development of a country highly defines its application of intelligent transport systems. For instance, Russia is known to be having the highest GDP compared to all the other 10 countries, and from the analysis, it has the highest application of ITS systems. Kyrgyzstan on the other hand has the lowest productivity. It has been postulated that the SCM systems of a country like Kyrgyzstan tend to be very low in terms of efficiency compared to the ones in countries like Russia that enjoy high GDP. Countries like Kyrgyzstan have however continued improving their transport infrastructures and quality of trade in a bid to seal the gaps in supply chain management systems that exist between them and other high-income countries like Russia (Ponomarenko et al., 2020).

Evidence indicates that when a country lags behind considerably in terms of its transportation and SCM systems as compared to its neighboring nations, ISC systems prefer routes that are developed and safer for their goods (Kucharčuková et al., 2012). This consequently affects the economic development of the various countries in the CIS region. More particularly, a report by the United Nations Economic Commission for Europe (2017) indicated that ISCs provide comparative advantages for various countries—improving their economies and creating local jobs.

In the following steps of the study, we project to provide more information about cargo tracking systems and the use of more advanced sensors on board and connectivity. This can help us to have a larger optic on the subject.

6 LIMITATIONS OF THE STUDY

The key limitation in this study was obtaining representative data for all of the CIS countries. The countries have different populations and it may not be practically possible to obtain same number of respondents for all the countries—an issue that introduced bias. However, owing to the vastness of the countries, it was difficult to get representative numbers from all states and still be able to attain the sample size of 500 respondents in total. This was still achieved but it brought with it a lot of logistical re-adjustments. Future studies can improve data collection techniques by using purposive sampling frameworks.

7 CONCLUSION

Intelligent Transport systems provide a number of comparative advantages for countries. Comparative development should be achieved by the various CIS countries in infrastructure to leverage the benefits of ITS systems. Additionally, users' express concerns about privacy and security of ITS systems. Ensuring security of freight cargo will be critical to supporting various ITS systems.

As a next step, we are planning to create a data set for one of the countries and follow the same methodology. With a number of 500 participants, study the each state separately and to finalize our conclusion as the study remain a work in progress.

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REFERENCES

Anholcer, M., Hinc, T., & Kawa, A. (2019). Losses in Transportation—Importance and Methods of Handling. In *SMART Supply Network* (pp. 111-128). Springer, Cham.

Badalyan, G., Herzfeld, T., & Rajcaniova, M. (2014). Transport infrastructure and economic growth: Panel data approach for Armenia, Georgia and Turkey. *Review of Agricultural and Applied Economics*, *17*(2), 22-31.

Dries, L., Gorton, M., Urutyan, V., & White, J. (2014). Supply chain relationships, supplier support programmes and stimulating investment: evidence from the Armenian dairy sector. *Supply Chain Management: An International Journal*.

Fayezi, S., O'Loughlin, A., & Zutshi, A. (2012). Agency theory and supply chain management: a structured literature review. *Supply chain management: an international journal*, *17*(5), 556-570.

Hartwell, C. A. (2013). A Eurasian (or a Soviet) Union? Consequences of further economic integration in the Commonwealth of Independent States. *Business Horizons*, *56*(4), 411-420.

Harvey, J., & Kumar, S. (2020, May). A Survey of Intelligent Transportation Systems Security: Challenges and Solutions. In *2020 IEEE 6th Intl Conference on Big Data Security on Cloud (BigDataSecurity), IEEE Intl Conference on High Performance and Smart Computing, (HPSC) and IEEE Intl Conference on Intelligent Data and Security (IDS)* (pp. 263-268). IEEE.

Kelarestaghi, K. B., Foruhandeh, M., Heaslip, K., & Gerdes, R. (2019). Intelligent transportation system security: impact-oriented risk assessment of in-vehicle networks. *IEEE Intelligent Transportation Systems Magazine*, 1-1.

Kucharčuková, O. B., Babecký, J., & Raiser, M. (2012). Gravity approach for modelling international trade in South-Eastern Europe and the Commonwealth of Independent States: the role of geography, policy and institutions. *Open economies review*, *23*(2), 277-301.

Mangiaracina, R., Perego, A., Salvadori, G., & Tumino, A. (2017). A comprehensive view of intelligent transport systems for urban smart mobility. *International Journal of Logistics Research and Applications*, *20*(1), 39-52.

Marotta, A., Studer, L., Marchionni, G., Ponti, M., Gandini, P., Agriesti, S., & Arena, M. (2018). Possible impacts of C-ITS on supply-chain logistics system. *Transportation research procedia*, *30*, 332-341.

Novikov, A., Novikov, I., Katunin, A., & Shevtsova, A. (2017). Adaptation capacity of the traffic lights control system (TSCS) as to changing parameters of traffic flows within intellectual transport systems (ITS). *Transportation Research Procedia*, *20*, 455-462.

Ponomarenko, T., Nevskaya, M., & Marinina, O. (2020). An assessment of the applicability of sustainability measurement tools to resource-based economies of the commonwealth of independent states. *Sustainability*, *12*(14), 5582.

Radosevic, S. (2011). Science-industry links in Central and Eastern Europe and the Commonwealth of Independent States: conventional policy wisdom facing reality. *Science and Public Policy*, *38*(5), 365-378.

Sharipbekova, K., & Raimbekov, Z. S. (2018). Influence of logistics efficiency on economic growth of the CIS countries.

Silvestre, B. S. (2015). Sustainable supply chain management in emerging economies: Environmental turbulence, institutional voids and sustainability trajectories. *International Journal of Production Economics*, *167*, 156-169.

Swami, S., & Shah, J. (2013). Channel coordination in green supply chain management. *Journal of the operational research society*, *64*(3), 336-351.

Traganos, K., Grefen, P. W. P. J., den Hollander, A., Turetken, O., & Eshuis, R. (2015). Business model prototyping for intelligent transport systems: a service-dominant approach. *Beta Publication*, *469*, 7.

Tundrea, A. C., Draganescu, C., & Popa, C. (2017, May). Integrating Intelligent Transport Systems in a Risk Management System of Systems. In *2017 21st International Conference on Control Systems and Computer Science (CSCS)* (pp. 385-391). IEEE.

UNECE. (2017). Strengthening the capacity of developing and transition economies to link to global supply chains through the reduction of trade obstacles. Retrieved from https://unece.org/fileadmin/DAM/trade/TF_JointUNRCsApproach/SCM-in-CIS_ENG.pdf

Ushakov, A., & Łukasik, Z. (2017). Modern container tracking systems on russian railroads: technologies and prospects. *Autobusy: technika, eksploatacja, systemy transportowe*, *18*.

Veres, P., Bányai, T., & Illés, B. (2017). Intelligent transportation systems to support production logistics. In *Vehicle and Automotive Engineering* (pp. 245-256). Springer, Cham.

Yang, G. H., Xu, K., & Li, V. O. (2010, May). Hybrid cargo-level tracking system for logistics. In *2010 IEEE 71st Vehicular Technology Conference* (pp. 1-5). IEEE.

APPENDIX

Survey One: For Users

1. How long did it take for the product to reach you?
   a. Less than a day
   b. Less than 3 days
   c. Less than a week
   d. More than a week
   e. More than a month
2. Was the delay caused by inefficiencies in supply chain management systems?
   a. Yes
   b. No
3. If yes, what was the problem and what do you think could have been done differently?
   a. Open Question
4. Have you ever lost your ordered goods while they were still on transit?
   a. Yes
   b. No
5. If yes, was the transporting mode, e.g track, fitted with a cargo tracking device?
   a. Yes
   b. No

Survey Two: For Providers

1. What type of goods do you deliver?
   a. Solid Goods
   b. Products
   c. Perishable Food
2. What country do you work in?
   a. Open Question
3. Are there any problems during the transportation phase?
   a. Yes
   b. No
4. Evaluate the infrastructure of your country for work in a scale of 1 to 5 where 1 is poor and 5 is excellent
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5
5. How often are there cases of loss of goods? (rare - always)
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5
6. Do you use cargo tracking devices?
   a. Yes
   b. No
7. How would you rate the performance of SCM applications? (bad to god)
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5