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What should managers of Intermodal Freight Transport companies consider before adopting Intelligent Transportation Systems (ITS)?

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Abstract

Despite the rapid growth of Information and Communication Technologies (ICT) and their benefits for business processes, intermodal freight transport companies still face challenges in ICT adoption including low compatibility, low level of management support and insufficient awareness of the expected advantages. This may prevent companies from thoroughly deploying ICT, although the benefits of being proactive in Intelligent Transportation Systems (ITS) adoption are largely documented. This study investigates the antecedents of ITS adoption in intermodal freight transport companies at both the levels of company and managers. This is important because the uptake of recent ICT advantages in the intermodal freight transport arena seems slow and the evidence on the determinants of such posteriori acceptability of ITS is limited in current applied ITS studies. A framework is presented that identifies four broad categories of environmental, organisational, technological and individual characteristics, and show how these categories influence the decision-making process of both companies and managers to adopt ICT in the intermodal freight industry. This adoption framework draws on theoretical perspectives in Technologic, Organization and Environmental (TOE) theory and Unified theory of Acceptance and Use of Technology (UATUA). The implications of this research are discussed for academicians and practitioners.

Keywords: Inter-modal Freight Transport; ITS; Adoption; UTAUT; TOE

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1. INTRODUCTION

Nowadays the significant growth of ICT is commonly recognised, as well as their benefits for business processes (Crainic et al., 2009; Cooper & Schindler, 2013). Focusing on the freight transport industry, ICT applications have proved to be particularly beneficial to increase efficiency and effectiveness (e.g. Harris et al. 2015; G. Giannopoulos, 2014; Marchet et al., 2012), although their adoption rate seems still limited.

In the freight transport industry, inter-modal transport is a specific type of multi-modal transport in which goods movement is a combination of at least two modes of transport in a single transport chain (Marchet et al., 2012). Inter-modal transport processes are particularly critical due to the high number of players involved, requiring interactions and information exchange (Dürr and Giannopoulos, 2003), and the need for integrating different modes of transport (i.e. road and rail, sea, or air transportation) when handling goods throughout the whole delivery process (Kia et al., 2000; Marchet et al., 2009). In this complex scenario, they still face challenges in ICT adoption including low compatibility, lower level of management support and insufficient awareness of the expected advantages (Cooper & Schindler, 2013; Marques et al., 2011; Capgemini, 2008; Bontekoning et al. 2004). These may prevent companies from

thoroughly deploying ICT despite the benefits of being proactive in ITS adoption are widely documented (Marchet et al., 2012; Wagar, 2010; Giannopoulos, 2004; Loebbecke and Wareham, 2003). In fact, the existing literature highlights that the ICT uptake in the inter-modal freight transport arena still seems slow and the evidence on the determinants of such posteriori acceptability of ITS is limited in current applied studies.

In this scenario, it is particularly valuable to investigate further the factors underlying ICT adoption in the inter-modal transport industry sector. In Some researchers have already mentioned the need for identifying factors that have an influence on company ICT adoption (e.g. Paenpluem, W., & Thammakoranonta, N., 2012; Adell, 2010; Pianelli et al., 2007; Schade and Schlage, 2003). Besides, exploring ICT adoption and its impact on logistics and transport companies has been identified as promising for future research (e.g. Wilson et al., 2015; Harris et al., 2015).

Specifically, the objectives of the present paper are as follows:

2. To investigate ICT adoption among inter-modal freight transport companies
3. To identify the individual factors that encourage/discourage ICT adoption
4. To identify the company factors (including technology, organisation and environment contextual factors) that encourage/discourage ICT adoption
5. To investigate the interrelationship between individual and company factors.

This paper is organised as follows. The next section summarises the literature review concerning both ICT adoption among inter-modal freight transport companies and existing theories related to ICT adoption. Section 3 illustrates the proposed framework and related hypothesis. Finally, section 4 concludes the paper and discusses future work.

2. LITERATURE REVIEW

2.1 Types of ICT available for freight transport

Researchers have provided various categories of ICT applications in the transportation field, based on the wider offer available in recent years (Evangelista and Sweeney, 2006). For instance, Giannopoulos (2004) categorised ICT types under three headings: network operation and management (related to transport modes), freight transport system operation and management (related to ports and terminals), and information and guidance to the users (related to the entire transport system). Pokharel (2005) provide another example. He classified ICT applications into accounting/financial, warehouse management system, E-commerce/EDI, transportation management system, workflow system, time management, project management, enterprise resource planning, and inventory management. The study by Golob and Regan (2002) investigated recognitions concerning three distinct sorts of ICT applications: those possibly utilised by dispatchers, those utilised by drivers directly, and advanced traveller information systems. As another case of classification, Marchet et al. (2009) identified four primary classifications in which ICT can also be used in intermodal freight transportation systems including transportation management (TM), supply chain execution (SCE), field force automation (FFA), and fleet and freight management (FFM) applications.

2.2. ICT adoption among inter-modal freight transport companies: needs and requirements

About two decades, studies on intermodal freight transport companies and ITS have achieved growing research interest (Caris et al., 2013). Concerning the particular effect of ICT on transport systems, Crowley (1998) expressed that ICT influence transport in any event in three different ways: expanding the information content of transported goods, developing supply chain integration, and giving different management and control tools.

The existing barriers are mainly technological, environmental and organisational and also the managers' perspective assumes a vital role in ICT adoption among intermodal companies. In

daily operations and management, this could promote lost confidence and decrease the general utilisation of ICT applications (Pokharel, 2005). Economic and financial factors are other constraints. For instance, significant investment requirements, implementation costs, management and maintenance costs, and the unfavourable financial conditions of related companies (Zeimpekis et al., 2006; Evangelista and Sweeney, 2006; Pokharel, 2005; Hollenstein, 2004; Jakobs et al., 2001; Lind, 1997).

Management capability largely affects how companies perceive the adoption of ICT (Min and Galle, 2003; Shiels et al., 2003). The expense of installing, interfacing and integrating new technologies with the legacy system (Jakobs et al., 2001), lack of management support (Proudlock et al., 1999) and the uncertainty of commercial accomplishment on ICT applications (Evangelista et al., 2006) could be other hurdles in ICT implementation. Besides, unfamiliarity with the commercially available ICT applications and difficulties in quantifying the potential benefits of ICT (Pokharel, 2005), as well as the deficient strategic orientation of ICT management (Hollenstein, 2004) could lead to the insufficient reception or inappropriate use of ICT applications in daily operations and management. In this way, ICT may not be used efficiently and effectively to facilitate the entire inter-modal transport process.

Also, company size plays a crucial role in ICT implementation level. The literature seems to highlight that a higher level of ICT implementation is seen positively together with the expansion in the size of logistics companies (Davies et al., 2007; Pokharel, 2005).

Company environment-related barriers are discussed by several scientists and researchers (e.g. Pokharel, 2005; Hollenstein, 2004; Zeimpekis et al., 2006; Harris et al. 2015) and include competitive pressure and trade partners' issues. In addition, every country policies could affect on ICT adoption because of the nature of inter-modal system that principally deals with international freight transport. Moreover, potential obstacles in most traditional firms are personnel reluctance to change or to learn new technologies (Huckridge et al., 2010; Perego et al., 2011)

Pro-ICT perception is another obstacle. As the vast majority of the logistics companies already have essential ICT infrastructure giving a range of logistics services to their customers, they may not have any apparent distinction on ICT (Pokharel 2005).

Despite the mentioned barriers, preparing real-time visibility, proficient information exchange, and better adaptability to react to unforeseen changes during shipment as ICT functions bring multiple benefits to companies (Durr and Giannopoulos, 2003; Coronado et al., 2009; Gunasekaran and Lenny Koh, 2009; Perego et al., 2011; Prajogo and Olhager, 2012). Knowledge about the pros and cons helps managers understand factors driving the ICT applications adoption among the transport and logistics industries.

Several studies have attempted to develop a holistic approach to assessing the importance of ICT adoption and the ICT role for transportation companies (Lin, 2014; Pokharel, 2005; Marchet et al., 2012; Hidalgo et al., 2009). According to the literature, there are a few cases illustrating inhibiting factors to adoption role in intermodal freight companies (Evangelista et al., 2012; Marchet et al., 2009; Matlay, 2004; Wagar, 2010, ; Chung & Wang, 2004; Hidalgo & López, 2009). Most of these studies, except Natasha (2016) have looked at a small subset of variables (e.g. performance expectancy, effort expectancy, social influence and facilitating conditions). A few studies have examined ICT adoption in the transportation industry and inter-modal freight transport companies (Marchet et al., 2009; Evangelista & Sweeney, 2014), but they did not attempt to identify the critical factors from both managers' and company perspective and do not distinguish posteriori ICT adoption factors.

Moreover, following the recommendation of Harris et al. (2015), existing information systems theories help link barriers/drivers and the adoption of technological trends within an inter-modal industry.

Thus, the need of further modeling the impact of ICT adoption for freight transport is still a lack. To be considered, the major factors involved based on existing ICT theories.

2.3. Theories used ICT research for technology adoption

Many theories are used in ICT research. Our interest is only in theories related to technology adoption. The Technology Acceptance Model (TAM) (Davis 1986, Davis et al. 1989), Theory of Planned Behaviour (TPB) (Ajzen 1985, Ajzen 1991), UTAUT (Venkatesh et al. 2003), Diffusion Of Innovation theory (DOI) (Rogers 1995), and Technologic, Organization and Environmental (TOE) framework (DePietro et al., 1990) are the most used theories. Information systems theories consider different levels (Oliveira & Martins, 2011). For instance, TOE and DOI take into account the firm level, whereas TAM, TPB and UTAUT are at the individual level.

Some social-psychological models have been created to define technology acceptance and use, with the more often used of these being TAM (Davis et al., 1989), and UTAUT (Venkatesh et al., 2003). TAM builds upon the Theory of Reasoned Action of Fishbein and Ajzen (1975). UTAUT depends on TAM by merging eight individual user acceptance models into an integrated model of acceptance (Venkatesh et al., 2003). It designates two direct indicators of system use – 'behavioural intentions' and 'facilitating conditions'. Behavioural intentions are thusly affected by 'performance expectancy', 'effort expectancy', and 'social influence. While UTAUT is well chosen as a robust tool for determining individual level technology adoption, it has frequently been used to accept the use of ICT, often in an organizational context, such as online banking (Zhou et al., 2010), e-portfolio systems (Shroff et al., 2011), e-government sources (AlAwadhi & Morris, 2008), ITS (Adell, 2010; Premkumar et al., 1997) and e-supply chain management (e-SCM) (Lin 2014).

Moreover, the TOE framework as initially introduced, and later adjusted in IT adoption studies, creates a helpful analytical framework that can be put on for studying the adoption and use of different types of ICT innovation at the organization level. The powerful theoretical basis and empirical support are needs of a potential application of information technology innovation domains which TOE framework has all of those. Moreover, across different studies identified vary factors within the three contexts (Oliveira and Martins 2011).

Thus, I especially draw on the literature of TOE framework, and UTAUT theory to investigate the drivers of adoption of ITS among inter-modal freight transport companies.

2.4. Technology Organization Environmental (TOE) Framework:

An industry adoption and implementation of technological innovations processes is influenced by the technological context, the organizational context, and the environmental context (Tornatzky & Fleischer, 1990)

The technological context includes internal and external technologies used by the firm. Both the equipment and processes are technologies. The organisational context alludes to the characteristics and resources of the company, including the company's size, the degree of centralisation, the degree of formalisation, the managerial structure, human resources, some slack assets, and linkages among representatives. The environmental context incorporates the size and structure of the industry, the firm contenders, the macroeconomic context, and the regulatory environment (Tornatzky & Fleischer, 1990).

These elements present the way in which a company perceives the need to adopt new ICT, whilst also investigating those new forms (Micheni, 2015).

2.5. Unified Theory of Acceptance and Use of Technology (UTAUT) theory

Among the theoretical models of user acceptance, one of the most widely adopted in the ICT literature is UTAUT, developed by Venkatesh et al. (2003). The direct indicators of ICT usage intention are held by the theory. It expresses the constructs of both performance and effort expectancy, social influence, and facilitating conditions. Following validation of UTAUT in a longitudinal study determined it to represent 70% of the variance in usage intention (Venkatesh et. al., 2003).

2.6. ICT theories and transportation research

ICT adoption theories such as TOE, UTAUT, TPB, TAM, DOI, Task-Technology Fit (TTF) are rarely applied in transport research. For example, Norzaidi et al., (2007) studied the performance of middle manager by using intranet in the port industry. They used TTF and the structural equation modeling to predict managers' performance. Also, R. Natasha (2016) applied UTAUT theory in the area of driver support systems as a framework to assess the acceptance of a driver support system. A more recent survey by Pan and Jang (2008) developed a TOE framework incorporating eight factors (i.e. IT infrastructure, size, technology suitability, perceived barriers, improvement of operations and production, growth of products and services rate, competitive pressure, and administrative policy) as important antecedents of ERP adoption. Moreover, Lin (2014) used a TOE framework to determine e-SCM adoption among both non-adopters and adopters. Previous researchers such as Premkumar et al. (1997) used the same theory to determine EDI adoption in the transport industry.

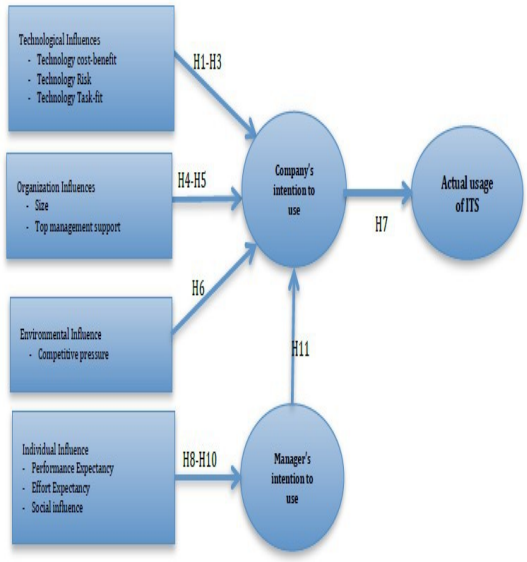
In this paper, the combination of TOE and UTAUT models has been deemed as interesting to be applied to the context of ICT among inter-modal freight transport companies from both managers' and organisation perspectives, since it summarises two of the most significant models applied in the ICT arena, and has already been used in other contexts outside ITS and inter-modal freight transport.

Conceptual framework on ICT adoption among Intermodal freight transportation companies

As previously highlighted, there is a need for a model describing the various factors that may influence the acceptance of ICT among inter-modal freight companies from managers and organisation perspectives. As Natasha (2016), Adell (2010), Lin (2014) and Rosli et al., (2012) suggested, UTAUT and TOE theories are suitable theories for ICT adoption in a transport context. Hence, the combination of TOE and UTAUT models is presented as a base for examining what influences the acceptance of ICT in inter-modal freight transport companies from managers' and organisation perspectives.

The proposed theoretical model in figure 3.1. identifies four broad categories of variables – technological, environmental, organisational and individual characteristics – on ICT adoption among inter-modal freight companies. A brief description of the framework and the research variables and justifications for the research hypothesis are hereinafter provided.

Fig. 3.1. Research framework- theoretical model that identifies four broad categories on ICT adoption among inter-modal freight companies



Technological context was found to be important in prior studies on company intention to use ICT (Leviäkangas & Lähesmaa ,2002; Haynes & Li, 2004), while organisation and environmental aspects were found to be important in studies of adopting new technologies in transport research (Teo et al., 2006; Salwani et al., 2009; Yeh et al., 2014). Also, manager's intention to use new technologies is mentioned by previous researchers as adequate consideration for actually deploying ITS (Madigan

et al., 2010; Hong et al., 2008; Hwang and Lu, 2013; Kumar et al., 2014).

2.7. Technological characteristics

Technology cost-benefit analysis

Technology cost-benefit is important to fully assess the effectiveness of any approach to evaluate different kinds of ITS applications (Haynes & Li, 2004; Lind, 1996; Perrett and Stevens,1996;), calculate the profitability of variety of investments in the transport sector (Leviäkangas and Lähesmaa 2002), measure ICT performance (Tan et al., 2010), and examine the increased global visibility provided by ITS based on cost-benefit analyses (Mason et al., 2003). Therefore, ICT cost-benefit was found to be important in prior studies on company's intention to use new technology. Hence, the first hypothesis is formulated, stating that:

H1: Technology cost-benefit analysis significantly affects technological intention to use ICT in inter-modal freight transport companies.

2.8. Technology risk

All investments involve not only costs but also risks, as expenditures incur in exchange for long-run benefits and return (Tiernan & Peppard, 2004). Implementing ICT could be risky as the company may confront threats and vulnerabilities, which lead to dissatisfaction being used (Hall, 2008; Romney & Steinbart, 2006). Moreover, Leviäkangas & Lähesmaa (2002) mentioned the need to look at the risks related to ITS investments. In addition, ITS carries a consumer-acceptance risk, which in turn entails the risk of not achieving the desired impacts. Consequently, it is hypothesized that:

H2: Technology risk significantly affects technological intention to use ICT in inter-modal freight transport companies.

2.9. Technology task-fit

Technology task-fit is the degree of matching ITS applications and tasks that need to be performed in inter-modal freight transport companies. Technology task-fit is reflected by the interaction among task complexity requirements (e.g. non-routines, interdependence, and job title), individual abilities (e.g. training, experience, IT skills) and ICT functions. Prior studies suggested that suitability of a system must be considered when implementing ICT in an organisation (DeLone & McLean, 2003). Furthermore, technology task-fit influences the usage of ICT (Goodhue & Thompson, 1995). For instance, Amentae and Gebresenbet (2015) reported the impact of task-fit on the company performance and intention to use new ICT among inter-modal freight transport companies. So, if there is not fit between tasks, then the company performance would decrease. To test this, the following hypothesis was developed:

H3: Technology task-fit significantly affects the intention to use ICT in inter-modal freight Transport Company.

2.10. Organizational characteristics-Size

The company size is expressed through the number of employees of the company (Koehler et al. 2010; Heinle and Strebel 2010; Repschlaeger et al. 2013). Researchers have found company size to be an important variable in the adoption of new information technology (Lin, 2014; Low, C. et al., 2011; Teo et al., 2006; Dholakia et al. , 2004; Kuan and Chau, 2001).

Larger companies have a greater ability to mobilise the resources required for adopting innovations. Empirical research suggests that lack of technical knowledge and resources hinder ICT use in small firms (Cragg & King, 1993), and therefore smaller companies are less likely to adopt new technologies such as EDI (Saunders & Clark, 1992; Bouchard, 1993; Reekers & Smithson, 1996). As such, the size of a company plays a crucial role in adopting technological knowledge (Lanctot & Scott, 2000; Hidalgo & López, 2009).

Some researchers stated that larger multimodal transport companies are more inclined to adopt ITS applications to support and improve their performance (Lin 2014; Coronado et al., 2009; Pokharel, 2005). Therefore, the following hypothesis is proposed:

H4: Company size significantly affects organisational intention to use ITS in inter-modal freight transport companies.

2.11. Top Management support

The significance of top management support and commitment for successful adoption of innovation is well documented in empirical studies. Spanos et al., (2002) examined the impact of ICT adoption on management praxis. The study reported evidence as to how changes in strategy, organisational structure, management systems and human skills link with the current and prospective level of utilisation of different sorts of advanced ICT. Wagar (2010) investigated whether the ICT adoption is associated with human resource management and organisational restructuring. The author highlighted that ICT adoption was strongly related to an employee number, organisational restructuring and investment in human resource management. Moreover, top management support has been consistently found to be essential for successful new ICT implementation in transport studies (Ab Talib et al., 2015; Ozbay et al., 2009; Boschian et al. ,2012). Ab Talib and Hamid (2014) also suggest that, apart from being financially supportive and setting up priorities, support from top management can influence the behaviour of employees who are reluctant to change. To test such relationship, the following hypothesis are identified:

H5: Top management significantly affects organisational intention to use ICT in inter-modal freight transport companies.

2.12. Environmental characteristics

Competitive pressure

Besides looking at the individual employee factor, there are other aspects that firms need to consider. The environmental context is the arena surrounding a company, consisting of multiple stakeholders such as competitors, suppliers, customers, government and community. Competitive pressure describes the current market situation, which makes companies look for new strategies and markets (Altinay 2006; Tehrani 2013). Competitive pressures force many companies to adopt ICT or lose business if they are not part of the network in the transport industry (Santos et al., 2015; Hidalgo and López, 2009; Martner and Garcia 2015). Therefore, competitive pressures are among the most often mentioned reasons for adopting ICT. The following hypothesis is thus proposed:

H6: Competitive pressure significantly affects environmental intention to use ICT in intermodal-freight transport companies.

2.13. Individual characteristics

Performance expectancy

Performance expectancy is described as the extent to which an individual believes that using a specific new system will help him or her attain job performance benefits (Davis 1989). Performance expectancy is the strongest predictor of intention to use a new technology (Venkatesh et al., 2003).

In transport studies, Madigan et al. (2016), Honget et al. (2008), Hwang and Lu, (2013) and Kumar et al. (2014) empirically demonstrated that performance expectancy has a significant positive effect on intention to use the new system. Similarly, Norzaidi et al., (2007), Teo (2001) and Golob and Regan (2002) have empirically found a positive relationship between performance expectancy and a user's intention to use new transport technologies.

Refusal to use ITS applications could cause an adverse effect on the middle managers' performance, and subsequently on the inter-modal freight transport company overall performance. The following hypothesis is therefore formulated:

H9. Performance expectance significantly affects individual intention to use ICT in inter-modal freight transport companies.

2.13. Effort expectation

Effort expectancy is one of the UTAUT's elementary constructs. According to Venkatesh and colleagues (2003), effort expectancy is described as the degree of easiness that manager feels when using ICT applications. In other words, the easier users believe it is to use technology, the greater the chance of its acceptability and adoption. Effort expectancy has been referenced in numerous empirical studies on ICT adoption. These findings point to the positive effect of perceived effort expectancy on users' intention to use new technologies (Jaradat and Al-Rababaa 2013; Wu and Wang 2005; Yu 2012). For instance, Vlassenroot et al. (2006) measured public support for road safety measures, especially related

to the use of ICT in reducing inappropriate speed. They found that effort expectancy had an effect on the behavioural intention to use ICT as a new technology. Similar findings have been reported by Rosli et al. (2012), in a study on the impact of effort expectancy on the intention to use ITS applications, and by Ruth Madigan et al. (2016), who focused on the factors that might influence the acceptance of Automated Road Transport Systems. Based on this and other findings, it hypothesised that:

H9: Manager's intention to use ICT applications in inter-modal freight companies will be influenced by effort expectancy.

2.14. Social influence

Researchers have found that social influence significantly affects user's behavioural intention to use technology (Venkatesh et al., 2003). As an example, Adell (2009), measured drivers related to the intention to use new technologies. He found that social influence has a significant effect on the behavioural intention to use the system. Similar findings have been reported by Mosi London (2014), Satunin and Babkin (2014) in their studies on the impact of social influence on the intention to use ITS applications, and by Ruth Madigan et al. (2016), who focused on the factors that might influence acceptance of Automated Road Transport Systems.

In the ITS adoption context, social influence is defined as the degree of encouragement from other people (e.g. competitors, traders, and peer groups) that affect a manager's willingness to adopt ICT applications in inter-modal freight company. Hence, it is stated that:

H10: Social influence significantly affects individual intention to use ITS in inter-modal freight transport companies.

2.15. Manager's intention to use

This research posits that manager's intention to use ICT applications would impact inter-modal freight company intention to adopt them. This is because managers inclined to adopt ICT applications to help them achieve efficiency in their company are more likely to have an influence on their company to adopt ITS applications. Therefore, the following hypothesis is proposed:

H11: Intermodal freight Transport Company's intention to use ICT is affected by manager's intention to them.

Conclusions and future research:

3. CONCLUSIONS

The present paper focused on developing a framework based on existing theories for studying the adoption of ICT in the inter-modal freight transport industry from two points of view (i.e. company and manager's) to help inter-modal freight companies adapt and use ITS.

Implications of our findings are useful for both practitioners and academics. The framework provides new insights to managers on how they can effectively match ICT and their company needs and requirements to increase the performance of their companies. For academics, this study can be a starting point for expanding the already existing body of knowledge on adoption of ICT, and further studying how inter-modal freight transport companies can effectively exploit the benefits of ICT.

Future research might be done to give experimental evidence and validate the UTAUT-TOE framework. Additionally, the relationship between the constructs may also be further investigated.

Notes on contributor

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