Paradigm

Digital Transformation for Sustainable Safety in Agriculture: Extending eCall Systems beyond Road Transport

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Abstract. *Digital transformation is a key enabler of sustainability in all economic sectors, but perhaps especially in the agriculture sector where the intersection between technology-driven innovation, occupational safety, and rural resilience is critical. While smart agriculture is advancing, emergency response in agricultural settings remains underexplored, despite high operational risks. Existing studies emphasise digitalisation for productivity, overlooking how emergency communication systems support sustainable safety. This paper addresses that gap by examining the extension of automatic emergency call systems, originally developed for road transport, to agriculture as part of a digital transformation toward sustainable safety. Using a quantitative descriptive design, a structured questionnaire was administered to 185 agricultural workers. The study evaluates perceptions of risk, the perceived usefulness of emergency call technologies, and the willingness to adopt them. The results show a high awareness of the risks in agriculture and strong belief that emergency call systems can shorten response times to serious incidents. Most of the respondents expressed a willingness to explore or use such systems, particularly when supported institutionally or offered at low or no cost. Adoption barriers appear to be more economic and governance related than technical. The paper contributes to the digital transformation and sustainability literature by positioning emergency communication systems as a strategic infrastructure for social sustainability in agriculture and by expanding emergency call technologies beyond road transport, highlighting their potential to embed safety, digital innovation, and sustainability into rural and agricultural policies.*

Keywords: digital transformation, sustainable agriculture, eCall systems, emergency communication, occupational safety, technology adoption, innovation.

Introduction

Digital transformation has become a cornerstone of modern economic development and processes, structures, and public service delivery in all sectors have been transformed. Over the past years, there has been an increasing concern about sustainability in the context of digitalisation decisions, moving the focus from achieving effectiveness and productivity in the digital space to a broader

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impact related to social, economic, and environmental outcomes. In this environment, digital technologies can no longer be considered as a new technology only to be updated or enhanced but instead viewed as a strategic tool to achieve resilience, safety, and long-term sustainability. Agriculture is a uniquely instructive place from which to investigate the crossroads between digital transformation and sustainability. As one of the most valuable economic industries, agriculture is crucial for food security, rural development, and territorial cohesion. On the other hand, agriculture is known to have high occupational risks (related to heavy equipment, working in a secluded and restricted environment, and limited access to immediate emergency response). With these investments that go into smart agriculture, precision agriculture, digital monitoring, and others, the area of safety in new digital transformation has been less studied, at least relatively. The sustainability of agricultural systems cannot be evaluated solely by its environmental value or economic value. Equally fundamental is social sustainability, which encompasses protection of human life, safe work, and rural resilience. Risk in agricultural occupational accidents is still a major issue for many countries, many of whom have suffered heavy injuries or death. In these conditions, emergency response time is a key issue that affects outcomes. Delays in communication and intervention can greatly escalate the seriousness of injuries and the associated social costs, thus underscoring the need for effective emergency communications as part of any intervention. Emergency call systems have been shown to help save time and life in road transport. One of the implementations of best practices in the digital safety infrastructure is the eCall system that automatically sends relevant information to emergency services when an incident is reported, such as a serious vehicle crash. As a result of automated location-identification and direct emergency service communication that these systems have facilitated, eCall services have shown benefits in terms of response time reduction and reduction in social costs. However, the application of such measures has applied mainly in road transport, despite similar or even worse risk conditions existing in most other sectors. There are important characteristics of the agricultural sector in this sector that make it a natural candidate to explore the possible extension of eCall systems beyond road transport. Working in agriculture often happens in far off or rural areas where emergency services do not have a lot of reach to the public transport networks and the response time is extended. Additionally, agricultural machinery accidents are common when injured persons are unable to call an emergency manually. Automated emergency communication systems can be very helpful in reducing the distance between the onset of accidents and the emergency response in such cases. Although the literature of digital agriculture has grown substantially in recent years, much literature has focused on productivity increases, environmental monitoring, and technology advancement. The importance of emergency communication systems as a component of digitalisation strategies in agriculture has been less reported compared to other sectors. Most existing studies on occupational safety in agriculture focus on accident prevention, ergonomics, and regulatory compliance, whereas the post-accident phase and emergency response mechanisms have not yet been sufficiently interwoven with digitalisation discussions. This divide indicates a disconnect of conceptual ideas between digital transformation efforts and holistic sustainability targets in high-risk industries. As such, the management and policy considerations of how emergency call systems might be integrated into digitalisation strategies for agriculture require consideration of governance, adoption, and institutional support. Technological integration into agriculture is determined not just by perceived use value but by economic limitations, regulatory measures, and a supportive infrastructure. Thus, an understanding among agricultural workers of how benefits are to be garnered from emergency call systems and under what conditions they would be willing to use such a technology is very important to build effective digital transformation

policies that support the purpose of sustainability. In this context, this study explores the potential of eCall systems as a critical component of digital transformation that can improve sustainable safety and risk management in agriculture. The study is designed to investigate awareness of occupational risk, perceived usefulness of emergency call technologies, and willingness of agricultural workers to adopt such systems by focussing on their perceptions and attitudes. Research adds to the scholarship on digital transformation in that it extends the understanding of emergency communication systems beyond road transport and locates them within the area of strategic infrastructure that enables social sustainability in agriculture. The paper responds to the following research question with this background in mind: How can eCall systems support digital transformation and sustainability objectives in the agricultural sector? With this line of inquiry, two hypotheses are developed. The first hypothesis is that agricultural workers believe in the ability of eCall systems to reduce emergency response time in the case of extreme agricultural accidents. Hypothesis two argues that the acceptance of eCall systems in agriculture appears to depend on the presence or absence of economic and institutional barriers rather than resistance to digital technology.

Literature review

Digital transformation and sustainability in agriculture

Digital transformation is an emerging and prominent topic in agricultural research today, in terms of the use of digital technologies in production systems, management methods, and management decisions. In addition to productivity improvements, the more recent literature emphasises the increasing convergence of digitalisation and sustainability goals and that technology can be used to improve environmental performance, economic viability, and social outcomes in rural regions. Emerging digital approaches are increasingly described as enabling resilient and adaptive agricultural systems to address economic stressors, climate variability, and demographic changes. Various research are emphasising that sustainability in agriculture can never be achieved without a meaningful digital change. According to (Hrustek, 2020), digital technologies play an important role in sustainable agriculture through optimal resource utilisation, better monitoring, and more informed decisions (Klerkx et al., 2019) emphasise from a social science perspective that digital agriculture is not simply a technological advancement, but a sociotechnical reshaping underpinned by institutional architectures, governance frameworks, and user buy-in. Their analysis shows that successful digital transformation means that technological innovation and the social environment in which it is applied go hand in hand. Recent bibliometric studies also confirm the rapidly growing literature around smart agriculture and technical innovation, while noting the emergence of thematic clusters on sustainability and digital resilience. (Gherțescu et al., 2025) find that digital transformation in agriculture includes more sustainable stories, but empirical works are not equally spread among regions and subjects. Gleichzeitig, cybersecurity and digital vulnerabilities have been increasingly emphasized, consistent with agriculture networks becoming more reliant on interrelated digital systems. (Campoverde-Molina & Luján-Mora, 2025) point out that as agriculture becomes increasingly digitalised, new risks represent that demand strategic control practices and institutional readiness. Despite these advances, the predominant focus in the literature devoted to the domain of digital agriculture remains on efficiency, productivity, and technology. And the dimensions of social sustainability, especially in terms of occupational safety and emergency response, lack much focus. This imbalance indicates that while the fast-paced digital

transformation of agriculture is underway, sustainable and digitised areas are missing out due to the lack of integration of areas of high impact into sustainability-focused digital strategies.

Digital transformation, sustainability, and emerging gaps in agricultural research

Recent research on digital transformation in agriculture conceptualizes sustainability through environmental impact and operational efficiency, with a focus on digital technologies for resource monitoring, emission reduction, and progress toward climate goals. In this context, digitisation is linked to carbon footprint measurement, precision agriculture tools, and analytics-based environmental performance assessments that support broader sustainability objectives. Pătărlăgeanu et al. (2024) identify digital platforms, sensors, and analytical systems that monitor and improve farm-level environmental health. Similarly, comprehensive surveys of smart farming technologies highlight the use of artificial intelligence, machine learning, and Internet of Things (IoT) applications throughout all production stages, mainly to enhance productivity and optimise operations (Kasera, Gour & Acharjee, 2024). Systematic reviews of smart environments in digital agriculture illustrate how integrated sensor networks and technologies are structured to facilitate crop management, resource monitoring, and decision-making processes (de Avila & Barbosa, 2025). Although this literature advances the understanding of the environmental and operational aspects of agricultural sustainability, it largely neglects social sustainability, particularly occupational safety, emergency preparedness, and post-accident response in high-risk, remote farming environments. This gap underscores the need to expand sustainability-orientated digital transformation frameworks to include safety-critical infrastructure that protects human life, thereby providing a clear rationale for examining emergency communication systems such as eCall in agriculture.

Occupational safety and risk in agricultural environments

Agriculture is often rated among the most hazardous sectors of the economy, often cited as one of the most dangerous economic sectors, which leads to high accidents and deaths caused by the agricultural sector due to high levels of risks because of the heavy machinery, continual occupational accidents, and extended times pressure, and concentration of the workers in isolated working conditions leads to an increasing risk. A growing range of studies have documented the degree of such hazards in agriculture, and their socioeconomic/technical aspects underline the requirement of sound safety models. Empirical studies of agricultural machinery accidents show continued evidence of persistent patterns of high-level serious injuries associated with agricultural machinery accidents, particularly with tractors and other heavy machinery. (Facchinetti et al., 2021) in their longitudinal analysis of tractor rollover deaths in Italy found that such fatalities are the leading cause of death despite technical and regulatory changes that have been made in equipment design and regulations. In addition, (Gattamelata et al., 2021) focus on ergonomics and safety-orientated design to minimise the risk of accidents and avoid accidents and understand that precautions are not sufficient to eliminate all accidents. General systematic reviews further support the global magnitude of agricultural risks for injury injuries. (Raza et al., 2024) also report uniform trends of machine-related injuries through regions and emphasise an increasing number of injuries in rural workers and small-scale farmers are suffering to a higher degree. (Qi et al., 2024) take a public health perspective, identifying injury risk factors through standardised prevention frameworks, and showing post-accident response mechanisms to determine the outcome. The findings contribute to the argument that occupational safety in agriculture cannot stop with prevention but can also include emergency response and communication. Occupational safety is

an essential aspect of social sustainability from a sustainability point of view. Thus, sustainable agricultural development considers protection of human life and long-term reduction of disability and sustainable rural livelihoods. Regulatory measures and safety standards play a leading role in tackling the prevention and compliance of these incidents, however, which highlights the need for digital solutions to help in better emergency response once an accident occurs, a limited focus of research has been made. This gap reflects an understudied nexus of digital transformation, safety, and sustainability in agricultural settings.

Emergency communication systems and the role of eCall

Emergency communication systems are an essential part of public safety infrastructure that allows for a rapid response and coordination during emergency incidents. Throughout Europe, an emergency number, 112, has been developed extensively to increase reach, make location more accurate, and reduce response delays. Technological improvements in emergency communication have resulted in quantifiable increases in response speed and service coordination in member states according to the (*2024 Report on the Implementation of the EU Emergency Number 112 | Shaping Europe's Digital Future*, n.d.). Of these technologies, the eCall system is a major example of digital safety innovation. Designed to send location and crash data from an accident to emergency services in response to more serious road accidents, eCall has been widely adopted to minimise lost lives and social expenses. Studies focussing on transport suggest that an automated emergency call solution substantially improves response times for emergency contact responses (including callers who do not have the time to manually initiate the call). Empirical evidence for these dynamics is given by (Kim et al., 2022) who, for instance, document reduced traffic fatalities and related societal costs because of eCall system implementations. The policy and implementation materials published by the European Emergency Number Association emphasise the strategic importance of eCall as part of emergency communication in general. The organisation's documents indicate that eCall does not work simply as a technical instrument, but an integrated element of emergency response ecosystems, which require interoperability, governance coordination, and institutional preparedness (European Emergency Number Association, 2015; 2023). These strengths of eCall that make it relevant for discussions of digital transformation in other high-risk sectors. Notwithstanding its well-established effectiveness in road transport, the application of eCall in practice has been only confined to selected sectors. However, the literature offers limited discussion on the potential use of automated emergency call systems in the agricultural context, where isolation, machinery-related hazards, and delayed emergency response are often present. This absence is remarkable given that most agricultural accidents occur in remote areas, where workers can be incapacitated, limiting manual communication with emergency services.

Technology acceptance and adoption in agriculture

Knowing how we use technology is vital when studying when and how emergency call systems might be extended. Traditional models of technology adoption highlight the importance of perceived usefulness and perceived ease of use as antecedents of user attitudes toward digital technology. (Davis, 1989) showed that people are more likely to accept technology that they view to be useful and manageable within their working conditions. Based on this ground, (Venkatesh et al., 2012) demonstrate the influence of facilitating conditions, cost considerations, and institutional support on acceptance behaviours. In addition, in agricultural environments, the adoption of technology is influenced by broader factors, such as economic limitations, the size of the farm, access to infrastructure, and trust in institutions. Some digital solutions will be met with resistance

although they are perceived as complex or costly, even when the positive aspects can be appreciated. On the other hand, technologies with well-established safety impact and policy support may face fewer deterrents toward acceptance. Little is known about how acceptance perspectives shape discussions of emergency communication systems. Although previous studies show the technical success of eCall, few analyze the conceptual landscape in which prospective users think about such systems outside their original domain. This gap also underscores the need for evidence-based research focusing on attitudes, perceptions, and the adoption of emergency call systems in agriculture.

Bibliometric analysis of the literature on digitalisation, sustainability and agriculture

Bibliometric analysis was carried out to complement the literature review. 199 articles indexed in the main scientific databases were used, which addressed the concepts of agriculture, sustainability, and digital economy. The analysis was carried out using VOSviewer software. Figure 1 illustrates the main links that allow the identification of thematic networks and research clusters.

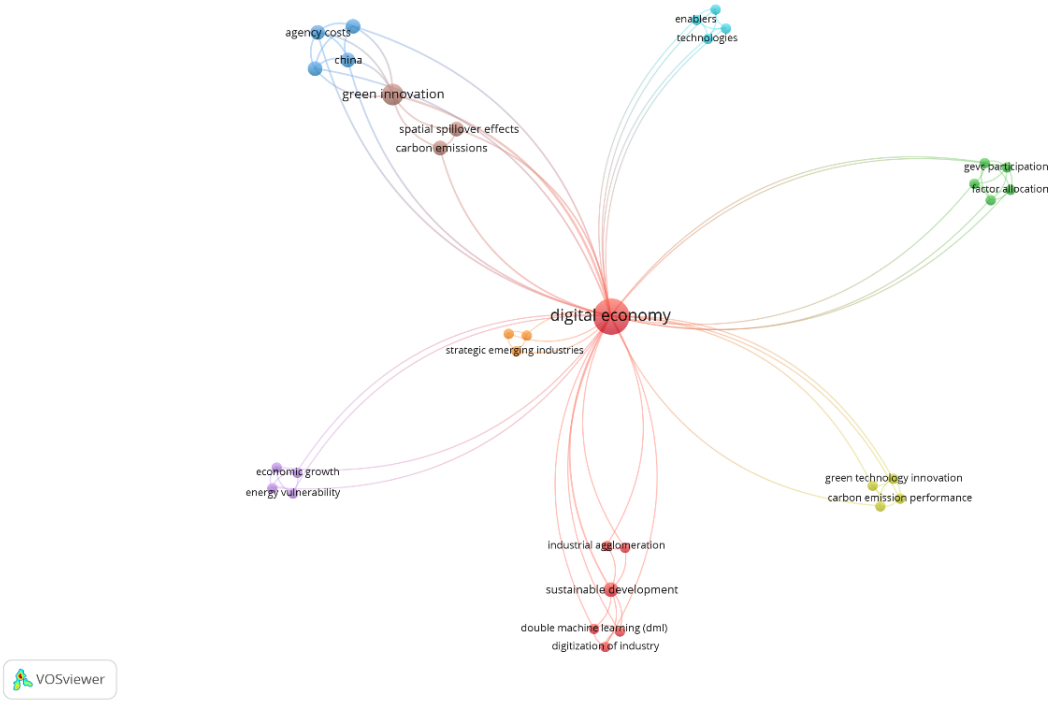


Figure 1 Thematic network of the literature

Source: Authors' own research using the VOSviewer software.

Following the analysis, the main cluster formed is red, which includes the following keywords: green innovation, carbon emissions, spatial spillover effects, and sustainable development. We can see that digitalisation is the main factor and contributes to the achievement of environmental objectives. Studies demonstrate the major impact of digital technologies on the efficient use of resources, reducing emissions, and stimulating green innovation. The literature also highlights various benefits at the regional and national level, following investment in digital solutions that lead to economic growth among farmers. In general, the group shows that digitalization is the key topic for improving environmental performance and supporting sustainable development. The green cluster brings together concepts such as government participation, factor

allocation, and institutional coordination, indicating the increased interest in the role of institutional structures in digital transformation. The literature emphasises that the progress of digitalization does not depend exclusively on technological progress, but on the existence of coherent public policies, coordination mechanisms, and effective governance models. The blue technology cluster includes terms such as technologies, enablers, and digital platforms, emphasising the infrastructures and tools that make effective digitalisation possible. The studies gathered here deal with the development of digital platforms, smart applications, the Internet of Things (IoT), and other support systems that allow data collection, transmission, and analysis. The literature highlights the fact that the functioning and management of modern agriculture is achieved with the help of a digital ecosystem, capable of transforming traditional production processes into advanced and sustainable systems. The purple colour is represented by notions such as economic growth and energy vulnerability, reflecting the concern for the relationship between digitalisation, economic performance and energy consumption. Studies demonstrate that the introduction of digital technologies contributes to increasing economic productivity and competitiveness, but, at the same time, can generate increased dependencies on energy infrastructure. Imbalances intensify in rural environments, where limited access to green energy and communication networks can reduce farmers' ability to adopt modern technologies. The last cluster, which is represented by the yellow colour in Figure 1, includes key words such as industrial agglomeration, digitisation of industry and strategic emerging industries. This group indicates the interest of researchers in the effects of digital transformation on sectoral organisation.

The literature marks the process in which digitalisation leads to the emergence of new industrial centres to stimulate economic growth. In this perspective, agriculture is analysed in close connection with the digital economy, becoming part of broader processes of industrial and technological integration.

Methodology

Research gap and positioning of the study

From the reviewed literature, it can be observed that studies on digital transformation in agriculture, occupational safety, and emergency communication systems are well separated. Despite the large existing body of literature, their intersection has been relatively little investigated. Research in this research theme is divided among the following: Digital agriculture research is geared toward productivity and sustainability outcomes, safety studies focus primarily on prevention and regulation, and emergency communication research focusses mainly on transport and urban settings. In conclusion, this split leads to a conceptual and empirical gap in the role of emergency call systems in digital transformation strategies to improve sustainable safety in agriculture. By addressing this gap in the literature, the current study investigates the perceptions of agricultural workers about eCall systems and readiness to adopt them, and supports a more integrated perspective of digital transformation, safety, and sustainability within high-risk rural environments.

Methodology

This study uses a quantitative descriptive research methodology to investigate perceptions on the role of eCall systems in relation to digital transformation and their ability to improve sustainable safety in agriculture. The methodology use is suitable to study an exploratory theme, that is, attitudes, perception, and adoption terms as opposed to technical performance or system deployment. Through the perspectives of agricultural workers, the research aims to offer empirical

support in the social and managerial aspects of extending emergency call systems beyond road transport. The structured online survey was conducted with agricultural workers operating in various geographical areas to collect data. To assess respondents' perceptions of occupational risk in agricultural activities, perceived usefulness of emergency call technologies, and willingness to adopt eCall-based solutions in agricultural contexts, the questionnaire was developed. Furthermore, the survey contained items on related adoption problems, for example cost concerns, institutional provision, and access to digital infrastructure. The survey tool was derived from the literature on digital transformation, occupational safety, and technology acceptance, and the conceptual approach to the survey instrument was designed to be consistent with the research questions. The final sample size consists of 185 valid responses. This sample size is sufficient for descriptive statistical analysis and identification of salient perception patterns in the population sampled. Respondents are from diverse demographics, educational level, and regionalities, providing a multifaceted perspective on attitudes toward digital safety solutions in agriculture. Participation was voluntary basis, and responses were anonymised to promote candid reporting, minimising potential social desirability bias. These factors considered were perceived accident risk, perceived benefit of eCall systems in shortening emergency response times, and use of a safety system, including their readiness to test or implement such systems if accessible. Perceptions were assessed using closed-ended questions that offered predefined responses and were easy to aggregate and compare. The study considered the analysis to determine patterns and the relationship of perceived usefulness, acceptance willingness, and contextual factors that influence acceptance. The results were collected from descriptive statistical methods and frequency distributions, and percentage analysis reported as well. This method was chosen to bring transparency and make inferences, consistent with the exploratory, managerial direction of the article. Instead of testing complex causal hypotheses, the analytical strategy focusses on the dominant attitudes and empirical evidence of the hypotheses. The first hypothesis is tested through the examination of respondents' perceptions of the impact of eCall systems on emergency response times in agricultural accidents. The second hypothesis is investigated in terms of willingness to adopt eCall systems regarding perceptions of economic and institutional factors. The results are considered considering the literature to give a reference framework to the findings; implications to be gleaned from these findings as well as to indicate some insights into the need for digital transformation strategies in addition to sustainability-orientated policy design. Although the selected approach gives important information on beliefs and receptivity to adoption, certain shortcomings should be noted. The use of self-reported data could potentially introduce subjective bias, and the descriptive nature of the analysis does not permit causal inference. Furthermore, the implementation outcomes discussed were not real world; thus, the study is focused on perceptions. We discuss limitations in the discussion and conclusion sections and the follow-up directions for future research.

Results and discussions

In this part, we highlight our findings and present the main empirical results obtained by an agricultural worker survey regarding the respondent's perceived occupational risk of the respondent, the perceived usefulness of eCall systems and conditions for potential adoption in an agricultural context. The results are discussed in terms of key theoretical concepts and in terms of the larger body of work in digital transformation, sustainability, and occupational safety. The results indicated a high level of knowledge about occupational hazards among agricultural workers. All respondents found that the current level of safety available in the use of equipment to be low, or very low as indicated in Table 1, therefore, indicating a general high level of vulnerability. Such

results seem to confirm the risk of agricultural activities and reflect the evidence that agriculture is one of the highest-hazard occupational sectors. This fact that all individuals report low safety levels indicates that safety-promoting digital solutions are very pertinent and stresses the importance of the provision of emergency response capabilities for sustainable agricultural development. In addition to general awareness of the risk, the respondents indicated that immediate emergency action would be crucial after a serious agricultural incident. The perceived effectiveness of the eCall systems in reducing the time to respond in an emergency is a primary result of the study. According to Table 1, almost half of the respondents to the survey considered that eCall systems could significantly reduce response times in case of agricultural accidents. Such perceptions provide empirical support of Hypothesis 1 that indicated that agricultural workers are aware of the potential of automated emergency communication systems to result in better post-incident outcomes. The use and utility of eCall is directly related to the experiences of the workers they serve when dealing with agricultural accidents, which could happen in isolated or rural regions where emergencies could take way too long, according to their own experience within the sector.

Table 1. Perceptions and willingness regarding eCall systems in agriculture

Survey item	Response category	Percentage (%)
Perception of safety level in the use of agricultural machinery use	Low / Very low	100
Perceived ability of eCall systems to reduce emergency response time	Significant reduction	46.5
Willingness to test or adopt eCall systems if provided at low or no cost	Yes	83.8
Main perceived barriers to adoption	High costs	30.8
	Lack of financial support	29.2
	Lack of information / training	17.3
	Lack of trust in technology	5.4

Source: Authors' own research.

The perceived importance of eCall systems is also supported by the perceptions as to the practical ways in which eCall systems could improve safety. As shown in Table 2, the most reported safety benefits are faster alerting of emergency services and automatic location data sharing. More than half of the participants also indicated that it is beneficial for eCall systems in cases of injury where injured people are unable to make an emergency call themselves. The results show that the respondents are more strongly associated with eCall systems related to efficiency of emergency communication than with preventive safety features. These perceptions are also consistent with the initial design to create eCall systems and indicate that the extension of eCall systems to agriculture may be an intuitive concept for potential users. Respondents also stressed the importance of eCall systems to reduce the time on call to emergent emergency responses for users of remote rural areas, which is especially true in agricultural contexts. Geographic isolation and equipment-related risks increase the probability of timely intervention influencing an accident outcome. In this sense, the perceived benefits presented in Table 2 underpin the notion of eCall systems as post-incident safety infrastructure that can address the human and social costs of agricultural accidents and contribute to social sustainability.

Table 2. Perception of ways in which eCall systems could improve safety in agriculture

Perceived safety improvement mechanism	Percentage (%)
Faster notification of emergency services	64.9
Automatic transmission of location data	58.4
Assistance in situations where the injured person cannot call	56.2
Reduction of response time in remote rural areas	51.4
Increased feeling of safety while operating machinery	42.7

Source: Authors' own research.

In addition to perceived usefulness, the study also investigated the willingness to adopt and assess eCall systems in agriculture. The findings show that adoption tends to be favourable under particular (favourable) conditions. More than four-fifths of the respondents (Table 1) indicated the desire to test or adopt eCall systems if they are made available affordably or at no cost. Therefore, this suggests that resistance to digital technology is not a barrier to adoption among the agricultural workers surveyed. Rather, acceptance seems to depend on outside enabling factors. Hypothesis 2 is also supported by the analysis of perceived adoption barriers. Economic limitations and inadequate institutional support or monetary backing were identified as major obstacles to adoption, and little trust in the technology was indicated by a minority of respondents. These findings are consistent with commonly accepted technology acceptance frameworks that underlie facilitatory, affordability, and institutional backing determinants of adoption practices. In agricultural settings, where investment can be challenging to facilitate, the role of subsidies, support programmes, or policy incentives is expected to be a key determinant in the adoption of safety-related digital technologies. From a digital transformation perspective, these results indicate that it is important to integrate emergency communication systems as part of overall sustainability and safety policies rather than offer them as standalone tech solutions. If eCall systems are embedded in institutional frameworks, which signal an organisational culture committed to occupational security and resilience to rural livelihoods, adoption is more probable. This integration can enhance trust, reduce perceived financial burden, and add legitimacy to digital safety interventions. To synthesise these relationships, Figure 2 presents conceptual information on eCall as a digital transformation mechanism for sustainable safety in agriculture. It allows you to see how agricultural accidents can prompt an automated emergency response communication mechanism, which will quickly translate to faster response times that lead to better safety performance. This figure illustrates the perspectives of participants, with the strategic role of eCall systems as post-incident safety infrastructure, as opposed to prophylactic technology, through the correlation of technological activation and the effects of social sustainability.

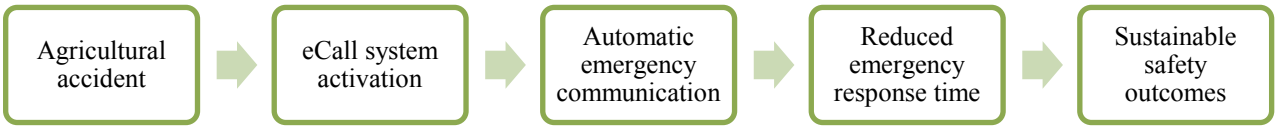


Figure 2. eCall systems as a digital transformation mechanism for sustainable safety in agriculture

Source: Authors' own research.

In general, the findings of this study reinforce the observation that current digital transformation initiatives in agriculture are predominantly geared toward productivity enhancement, environmental monitoring, and efficiency-driven sustainability goals. Existing research on agricultural digitisation largely emphasises carbon footprint measurement, resource optimisation, and AI- and IoT-enabled smart farming applications across pre-harvest, harvest, and post-harvest activities (Pătărlăgeanu et al., 2024; Kasera, Gour, & Acharjee, 2024; de Avila & Barbosa, 2025). On the contrary, the present study highlights that safety critical dimensions—particularly emergency preparedness and rapid response to severe occupational accidents—remain under-represented within dominant digital agriculture frameworks. Empirical results demonstrate a clear awareness among agricultural workers of occupational risks and a strong perceived value of emergency call technologies as life-saving infrastructure. In this sense, the study positions eCall systems as strategic components of social sustainability and rural resilience, complementing existing productivity and environment-focused digital solutions, and supporting a more balanced and inclusive approach to sustainable agricultural transformation. In general, the findings indicate that agricultural workers view eCall systems as suitable and able to solve the key safety concerns. The close convergence found between perceived usefulness; adoption readiness and the conditions of adoption indicate that the extension of eCall systems from road transport to other application areas is not only technically feasible but also socially acceptable. By situating emergency communication within the broader framework of digital transformation and sustainability, the results allow for a much fuller interpretation of what digital technologies mean for the safer and resilient system of agriculture.

Conclusion

This study analysed the role of eCall systems as a tool for digital transformation and aimed to improve sustainable safety in agriculture. The study adds to our understanding of how digital safety infrastructures can better support sustainability in high-risk sectors outside of their initial application domains by addressing agricultural workers of occupational risk, emergency response needs, and technology adoption conditions. The results show a perception of occupational hazard among industry workers and a strong emphasis on emergency intervention, which happens after a serious accident and should be taken as soon as possible. In response to such questions, respondents viewed eCall systems can drastically decrease emergency response times, which is particularly true in settings associated with geographic isolation and few outlets for emergency help. These perceptions highlight the relevance of emergency communication technologies as a post-incident safety solution, which has the potential to mitigate the human and social costs associated with agricultural accidents. The results also indicate a generally positive perspective on the adoption of eCall systems in agriculture when suitable economic and institutional conditions are established. The willingness to accept such technologies is rooted in perceived usefulness and is supported by financial and policy assistance, rather than resistance to digital innovation. This result also emphasises the need to embed emergency communication systems within integrated digital transformation and sustainability processes with the support of the public sector and sectoral governance mechanisms. Theoretically, this research contributes to the literature on digital transformation and sustainability by defining emergency call systems as part of the strategic infrastructure for social sustainability in agriculture. It connects previously separate research streams on smart agriculture, occupational safety, and emergency communication and promotes a coherent conceptualisation of digital safety in rural settings. The theoretical perspective that eCall systems can serve as a link that connects technological activation to more sustainable safety results

has been shown in the document, solidifying their importance within digital transformation agendas. From a pragmatic and policy perspective, these results are likely to believe that expanding eCall systems beyond road transport could be considered a feasible and socially accepted model to improve agricultural safety. Both regulatory authorities and industry can add emergency call technologies to agricultural machinery certification, safety programmes, and digitalisation initiatives, particularly in accident-prone areas with limited emergency responders. The level of integration could result in safer working conditions, superior rural resilience, and additional benefits of inclusive sustainability. There are several caveats to consider. The study is based on self-reported survey data that are potentially prone to perception bias, and the study used descriptive analysis that cannot draw causal inferences. The study also focusses on perceived usefulness as well as intentions for adoption instead of system implementation or performance of the system. Future research could address these limitations by investigating pilot deployments of new eCall systems in agricultural contexts, a longitudinal analysis of safety performance, or other comparisons between countries on institutional readiness to integrate digital safety. In summary, the research highlights the need to expand agriculture's digital transformation strategies to include sustainable technologies based on safety as a pivotal part of their sustainability strategy. Digitalisation can expand the context of eCall systems from mere transport on roads to safety, the conservation of human lives, and the resilience of agricultural communities in the long term.

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