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Application of Berlo's Communication Model to Agile Software Development with Scrum in Distributed Teams

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Abstract. This study examines communication challenges in distributed teams operating within the Scrum framework. To enhance communication effectiveness, Berlo's model was adapted. An instrument was developed and validated by experts through surveys and interviews with professionals experienced in agile project management. The instrument was subsequently applied to 44 practitioners across seven countries, assessing its capacity to improve communication and optimise the flow of information between teams and stakeholders. The findings confirmed that the adaptation of Berlo's model is effective in addressing communication challenges in distributed teams. In conclusion, the implementation of Berlo's model in Scrum teams reinforces clarity and cohesion in communication, thereby contributing to the success of agile projects in global environments.
Keywords: Communication challenges, Berlo, communication model, Scrum, global software development.

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1 Introduction

Globalization and technological advancement allow software development teams to be distributed in various geographical locations, which increases the need for effective communication models to coordinate their work. The agile framework Scrum emerges as one of the most popular solutions for managing software projects due to its flexibility and iterative approach (Beck et al., 2001). However, the application of Scrum in distributed teams faces several challenges, particularly with regard to communication, a fundamental aspect to ensure the successful delivery of quality software products (Hossain et al., 2011; Luz et al., 2009). Global Software Development (GSD) is a growing trend in software engineering due to its multiple benefits, such as cost reduction, access to skilled labor and the possibility of continuous work. Many organizations combine GSD with agile methodologies, thus achieving faster development and better project control. This combination makes it possible to optimize resources, guarantee higher quality products and take advantage of the benefits of having teams distributed in different locations (Ammad et al., 2019; Bannerman et al., 2012; Bundhun & Sungkur, 2021; Shafiq et al., 2019).

Although several studies highlight the importance of communication in distributed teams, few address the adaptation of theoretical communication models to the specific context of distributed Scrum. Berlo's SMCR model, which emphasizes the sender, message, channel, and receiver, provides a robust framework for improving communication in distributed Scrum teams. The message component includes code, elements, structure, content, and processing, influenced by the participants' communication skills, attitudes, knowledge, and sociocultural context. However, empirical validation of this model in distributed Scrum environments remains limited, as noted by Ammad et al. (2019), who highlight the need for further research to adapt and validate communication models in such contexts.

Adapting Berlo's communication model to a Scrum environment distributes messages effectively, improving communication and contribution to the fulfillment of requirements in projects.

This article aims to validate the adaptation of Berlo's communication model (SMCR) in distributed teams using the agile Scrum methodology. To validate this adaptation, an instrument was designed and evaluated by experts using the Delphi method (Almenara & Moro, 2014), a qualitative method widely recognized for its ability to assess the appropriateness and applicability of theories and models in specific contexts through surveys and interviews with professionals with experience in agile project management. Subsequently, this instrument was applied to 44 software development specialists from seven countries operating under the Scrum framework.

The present research offers an empirical evaluation of the applicability and effectiveness of Berlo's communication model in the context of distributed agile software development teams. It examines how the model's core components—source, message, channel, and receiver—can be applied to enhance communication flows among geographically dispersed team members. The study focuses on improving coordination among key roles such as developers, Scrum Masters, Product Owners, and other stakeholders, aiming to reduce misunderstandings, clarify expectations, and facilitate effective information exchange. Ultimately, it is expected that enhanced communication, grounded in this theoretical framework, will increase team efficiency, minimize project delays, and support the timely delivery of high-quality software products.

A central challenge in project management under the Scrum framework, particularly in Global Software Development (GSD) environments, is the frequent non-compliance with project requirements due to communication breakdowns. These issues often stem from language barriers, cultural differences, and time zone gaps, resulting in misunderstandings and collaboration delays.

To address these issues, this research investigates the strategic use of Berlo's model to improve the clarity and effectiveness of communication within distributed Scrum teams. It aims to ensure accurate message transmission, foster mutual understanding, and support timely, constructive feedback. Among the specific objectives are to facilitate the effective reception and interpretation of messages across team roles, to reduce communication noise caused by geographical and cultural separation, and to establish feedback loops that support continuous improvement. Through this approach, the research aspires to offer practical insights for enhancing collaboration and ensuring better alignment with project goals in distributed agile environments.

2 Literature Review

Effective communication has been an essential pillar for the success of software development teams, especially in the GSD context. This environment has presented significant challenges, such as cultural differences, time zone disparity, and IT infrastructure limitations, which have made coordination and collaboration among distributed teams difficult. Several studies have highlighted the need to address these challenges by implementing specific tools and practices that promote efficient interaction. In this regard, a review of 184 articles by authors Defranco and Laplante (2017) has highlighted that the most active areas of research have included global development, project effectiveness and teamwork, predominantly using surveys as a methodology to delve into these issues.

In turn, in a study on GSD presented in Bhatti & Ahsan (2017), an Effective Communication scale was proposed based on a systematic literature review and a 29-item survey applied to globally distributed teams. The study highlights four essential elements for achieving effective communication: active stakeholder participation, cultural integration, appropriate use of technological tools, and timely access to information. These aspects demonstrated that the proposed model is simple and adaptable to the demands of global development.

A systematic review of 21 empirical studies on geographically distributed agile development has identified some persistent challenges such as cultural differences, time zones, and ineffective communication tools, and synthesized some techniques to mitigate these problems (Alzoubi et al., 2016). These findings have reinforced the need for communication practices adapted to agile and global contexts, as well as for developing tools that facilitate effective collaboration among distributed teams.

In recent literature, several empirical studies have explored the importance of communication in distributed teams, particularly in software development environments that have used agile methodologies such as Scrum. In a study published in *IEEE Access*, the impact of overall software development practice on the quality of communication within distributed teams was investigated (Ammad et al., 2019). This study identified that, although Scrum facilitates certain aspects of collaboration, the lack of clear communication between distributed team members has had a negative impact on team efficiency and final product quality.

An analysis by Santos et al. (2023) conducted a meta-analytic review of cases where Scrum was implemented in distributed environments. The study highlighted that, despite formal Scrum tools and processes, cultural, geographic and time zone

differences have created communication challenges that require additional solutions. The authors concluded that communication in distributed teams remains one of the biggest obstacles to the effectiveness of these teams.

In another study, specific communication problems that have contributed to project failure in distributed development environments were investigated. The results showed that communication errors have been one of the main factors that have negatively affected collaboration and timely delivery of projects. The article suggests the need for communication models tailored specifically for distributed teams using agile methodologies such as Scrum (Noor et al., 2021).

Likewise, in an article published in Information and *Software Technology*, Alsaqaf et al. (2019) examined the challenges in defining and managing quality requirements in distributed teams. This study reinforced the idea that poor communication has affected the correct interpretation and execution of quality requirements in software projects. The authors emphasize the need to use tools and models that improve communication and, therefore, the efficiency and effectiveness of distributed teams.

An article cited in *IEEE Access* points out that GSD faces significant challenges related to communication and coordination (Qureshi et al., 2021). These challenges are especially critical in the context of Requirements Change Management (RCM) and in the implementation of agile methods. On the one hand, the authors have proposed a conceptual model that improves communication and coordination management in RCM, achieving 87% effectiveness according to software development experts, who have also endorsed its practical implementation by 75%. On the other hand, a study identifies and prioritizes 22 key barriers to scaling agile methods in the GSD environment, classifying them into five main categories, “human resource management”, “coordination”, “technology”, “project management” and “software methodology”. In addition, the study proposed a taxonomy using the fuzzy-AHP (Analytic Hierarchy Process) method to address these barriers (Shameem et al., 2020).

The adoption of agile methods in geographically distributed teams faces cultural barriers, communication challenges and the need for methodological adaptations. Cultural differences, especially in projects with teams in India and Sweden, highlight hierarchical barriers that hinder the implementation of agile practices, with cultural training being a key solution (Šmite et al., 2021). In addition, distributed agile teams face critical communication challenges, such as cultural differences, time zones, languages, personal skills, and ineffective communication tools. A study based on interviews with distributed team members in Australia, China and India further identified a new challenge: insufficient documentation. Although solutions have been proposed, significant gaps persist, evidencing the need for more research and effective practices to mitigate these challenges (Alzoubi & Gill, 2021). In collaborative scientific environments, the Scrum framework proves effective in improving coordination and self-organization, although its adoption requires flexibility and an iterative approach to learning (Hidalgo, 2019).

Similarly, in a qualitative study, this author developed a theoretical model of effective communication in globally distributed Scrum teams, based on interviews with 10 industry professionals. The model identified three key components: transparency, quality and discipline of communication, which promote shared comprehension in the team. In addition, the study presented 11 practical actions to improve and to maintain effective communication; including*: convey and follow up on a message*, *create a safe environment for communication*, “respect personal boundaries when communicating across time zones” and “use agile practices for communication whether the team is distributed or not”. These strategies provide both, a basis for future research and useful guidance for practitioners (Kostin & Strode, 2023).

Another empirical study introduced EasyComm, a communication management framework designed to improve interaction between clients and teams in agile development projects, overcoming technical and geographical constraints (El-Najar et al., 2019). Inspired by social networking websites, EasyComm created a centralized and accessible communication hub. Interviews with experts validated its effectiveness, highlighting its acceptance and potential usefulness. Results indicated that lack of communication has affected most in the requirements elicitation phase, less in development, and moderately in testing or launch. Meanwhile, Yagüe et al. (2016) explored perceptions of global agile team members, demonstrating that tools such as smart boards and centralized repositories improve the sense of co-location and facilitate the exchange of critical information about the state of the process and product.

To synthesize the findings from the literature and highlight the gaps addressed by the proposed model, Table 1 presents a comprehensive comparative analysis of existing communication models and approaches currently applied in distributed Scrum teams. This analysis includes key criteria such as the clarity of message formulation, the presence and efficiency of feedback loops, adaptability to asynchronous communication, and integration with digital collaboration tools. By evaluating the strengths and shortcomings of each model, the table reveals persistent challenges related to message standardization, inconsistent communication flows, and limited support for real-time feedback in geographically dispersed environments.

The comparison reveals the urgent need for a structured, context-aware communication framework in agile environments. The proposed adaptation of Berlo's SMCR model offers a systematic solution by standardizing message delivery, enabling feedback, and integrating web tools. This model addresses both theoretical gaps and practical challenges in distributed Scrum teams.

Table 1. Communication Models in Agile Distributed Teams Using Scrum

Authors	Approach/Contribution	Strengths	Identified Gaps
Alzoubi et al. (2016)	Systematic review of 21 empirical studies on distributed agile development, identifying challenges such as cultural differences, time zones, and ineffective communication tools, and proposing mitigation techniques.	Synthesizes persistent communication issues and mitigation strategies.	Does not present a communication model adapted to Scrum.
Yagüe et al. (2016)	Explored perceptions of global agile team members regarding communication tools.	Demonstrated that tools like smart boards and centralized repositories enhance collaboration.	Does not develop a formal theoretical communication model; tool-centered approach.
Bhatti & Ahsan (2017)	Developed an "Effective Communication" scale based on a systematic review and survey.	Highlights stakeholder engagement, cultural integration, and tool usage.	Not adapted to Scrum ceremonies; lacks standardized templates or mechanisms for continuous feedback.
Defranco & Laplante (2017)	Review of 184 articles on communication in software development teams.	Identifies key research areas: global development, project effectiveness, and teamwork.	Broad scope lacks a communication model specific to Scrum teams.
Alsaqaf et al. (2019)	Study on challenges in managing quality requirements in distributed teams.	Empirically links poor communication with quality issues.	Focused on requirements; does not provide a comprehensive model for Scrum ceremonies.
El-Najar et al. (2019)	Introduction of the EasyComm framework for client-team communication.	Validated and tool-centered approach.	Tool-specific; not aligned with Scrum roles or ceremonies.
Ammad et al. (2019)	Studied the impact of communication issues on efficiency in distributed Scrum environments.	Show that communication deficiencies affect final product quality.	Do not propose a specific model to improve communication; emphasize the need for one.
Hidalgo (2019)	Case study on adapting Scrum in distributed scientific projects.	Demonstrates that Scrum enhances coordination and self-organization in scientific contexts.	Requires flexible adjustments; does not directly address communication challenges in distributed settings.
Shameem et al. (2020)	Classification of 22 barriers to scaling agile methods in distributed environments using fuzzy-AHP.	Proposes a useful taxonomy to prioritize and address communication, coordination, and HR obstacles.	General management focus; not specifically centered on communication models.
Qureshi et al. (2021)	Conceptual model for Requirements Change Management (RCM).	High effectiveness (87%); tailored to agile methods.	Limited to RCM; does not cover all Scrum ceremonies; lacks standardized templates or feedback mechanisms.
Alzoubi & Gill (2021)	Communication challenges in teams from Australia, China, and India.	Highlights the role of documentation and tools.	Identifies challenges but does not present a structured solution.
Noor et al. (2021)	Investigated how communication errors contribute to failure in distributed projects.	Identified poor communication as a key failure factor; suggest adapting communication models.	Does not present a specific structured model or strategies applied to the Scrum framework.
Šmite et al. (2021)	Studied cultural barriers in implementing agile practices in distributed teams.	Emphasizes the need for cultural training and methodological adaptation to overcome hierarchical barriers.	Does not propose a formal model; sociocultural approach.
Kostin & Strode (2023)	Theoretical model based on interviews; emphasizes transparency and feedback.	Identifies clear principles and practical actions.	Theoretical model not integrated with specific Scrum tools or fully aligned with Scrum ceremonies.
Santos et al. (2023)	Meta-analysis of Scrum case studies in distributed environments.	Identifies communication barriers despite Scrum tools.	Emphasizes the need to adapt models.
Proposed Model (Berlo adaptation)	Adaptation of Berlo's SMCR model to the Scrum framework with structured templates and the Comunica-Scrum tool.	Integrates standardized templates, continuous feedback, and language personalization.	Requires validation in real-world projects and integration with other tools.

3 Methodology

3.1 Steps for Adapting Berlo's Model to Scrum in GSD

The adaptation of Berlo's communication model to the Scrum framework in a Global Software Development (GSD) environment

followed a structured process to ensure its applicability and effectiveness. The steps undertaken are described below:

1. Literature Review and Model Selection: A review of several classical communication models—such as those proposed by Aristotle, Lasswell, Shannon and Weaver, Berlo, Jakobson, Schramm, Braddock, and Maletzke—was conducted to identify a suitable theoretical framework. Because of this analysis, Berlo's SMCR model was selected due to its focus on the key elements of the communication process: sender, message, channel, and receiver, which were deemed particularly relevant for addressing communication needs in distributed Scrum teams.
2. Analysis of Communication Needs in Scrum: The communication requirements of Scrum ceremonies (Refinement, Planning, Daily, Review, and Retrospective) were analyzed, identifying key challenges such as cultural differences, time zone disparities, and language barriers in GSD contexts.
3. Mapping Berlo's Components to Scrum: The components of Berlo's model (sender, message, channel, and receiver) were mapped to Scrum roles, ceremonies, and artifacts. For instance, user stories were identified as the primary message content, and the Comunica-Scrum application was proposed as the main communication channel.
4. Design of Standardized Templates: Templates were developed to standardize the structure and content of messages for each Scrum ceremony, ensuring clarity and consistency. These templates include fields for project details, objectives, and feedback.
5. Development of the Comunica-Scrum Application: A web application, Comunica-Scrum, was developed to facilitate the encoding, transmission, and feedback of messages. This tool supports multilingual communication and integrates with email and instant messaging platforms.
6. Expert Validation Using the Delphi Method: The adapted model and its components were validated through the Delphi method, involving iterative feedback from experts in Scrum and statistics to refine both the model and its evaluation instrument.
7. Evaluation via Survey: The model was applied to a sample of 44 professionals from seven countries. The feedback gathered was used to refine the templates and communication processes, ensuring the model's practical applicability.

3.2 Conceptualization Model

The adaptation of Berlo's (1984) communication model to the Scrum framework in GSD projects was previously discussed and proposed in Hernández-Bravo et al. (2022), where the analysis of various classical communication models such as those proposed by Aristotle (Serrano & Zapico, 2004), Lasswell (Serrano & Zapico, 2004), Shannon and Weaver (Baecker, 2017), Berlo (1984), Jakobson (Pilshchikov, 2021), Schramm (1972), Braddock (1958) and Maletzke (1992), among others, was performed. All of them emphasized the clear definition of the essential components of the communicative process, which evidences its relevance in different contexts.

In this study, Berlo's model was selected and is presented in Fig. 1, because of its emphasis on the fundamental elements of communication: sender, message, channel and receiver. The message is made up of five essential components: code, elements, structure, content and processing. These factors are determined by the communication skills, attitudes and knowledge of the participants, as well as by the social and cultural system in which both sender and receiver operate.

These elements have been previously pointed out in this paper as critical aspects that affect communication in Scrum teams. Consequently, the message must be encoded and translated into a language understandable to the receiver, choosing an appropriate communication channel.

The adaptation of Berlo's communication model applicable to the Scrum framework in a GSD environment is shown in Fig. 2. The application of this model in software development projects is adapted to the main events or ceremonies of the Scrum framework through the following elements:

Sender and Receiver**:** The senders, made up of the stakeholders and the Comunica-Scrum system, generate messages under predefined standards to guarantee their quality and clarity. To ensure fidelity in communication, message reception and interpretation confirmations are implemented. The transfer and exchange of information strengthens the knowledge of those involved, improving communication accuracy. To optimize the comprehension and effectiveness of information exchange, standard templates are established to codify and structure the message information shared in each event, avoiding omissions, speeding up discussions and keeping clear records.

Message: Messages are standardized in their code, content and treatment, using representations such as user stories or UML diagrams. In this context, messages have a clear purpose, follow a logical order and maintain a uniform style to minimize possible

misunderstandings. To this end, templates function as a structured guide that aligns everyone involved in each ceremony, allowing critical information to be shared clearly, completely and consistently.

Channel: The main communication channel is the Comunica-Scrum web application, which manages the sending, encoding, decoding, reception and notification of messages. In addition, it is possible to transmit messages via e-mail and instant messaging applications to interested parties. A key functionality of this application is the generation of reports, allowing users immediate access to relevant project information.

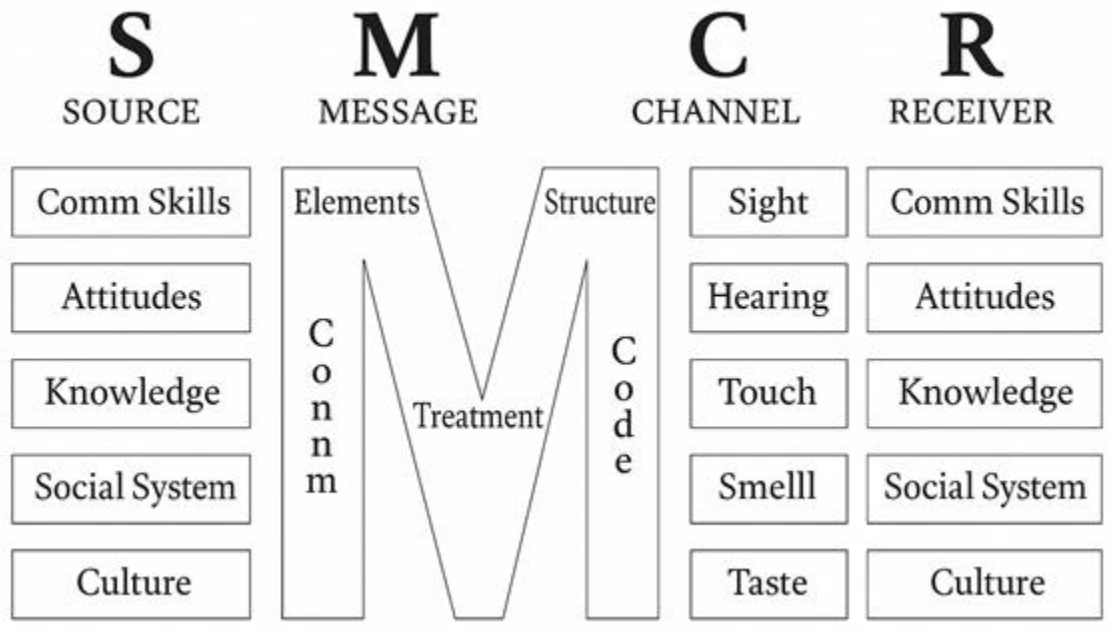

Fig 1. Berlo's Model.

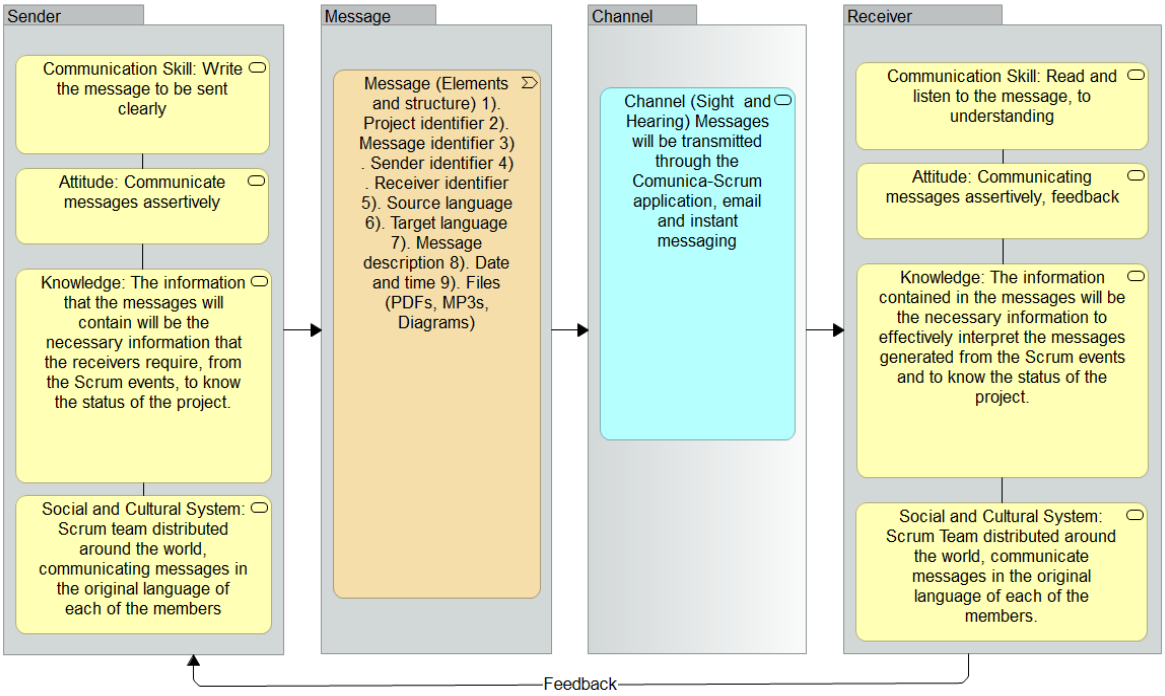

Fig. 2. Conceptual Representation of Berlo's Communication Model in the Context of the Scrum Framework.

3.3 Communication model design

This section presents the design of the communication model based on Berlo's model, applied to the processes and people involved in the creation and design of applications under the Scrum framework and within a GSD environment. The objective of this model is to favor communication in software projects managed under the Scrum framework, allowing fluid and structured interaction between key actors. Its application contributes to the fulfillment of project requirements, strengthening coordination and collaboration in distributed teams within the GSD context.

In the context of the ceremonies carried out during the development of a project under the Scrum framework, it was considered necessary to identify and organize the information transmitted between the sender and the receiver. This process was carried out taking the specific roles played by both parties into account, which allowed determining the flow of information in each event where communication was considered essential.

Fig. 3 shows the conceptual scheme of the solution, in which a main communication channel is established, through which the messages generated by the senders and received by the receivers are transmitted. These messages correspond to the events that occur during software development in projects managed under the Scrum framework, within a GSD environment.

Within this communication channel, messages can be generated manually or automatically, considering three key elements: the sender, the message (with its structure and complete information) and the receiver.

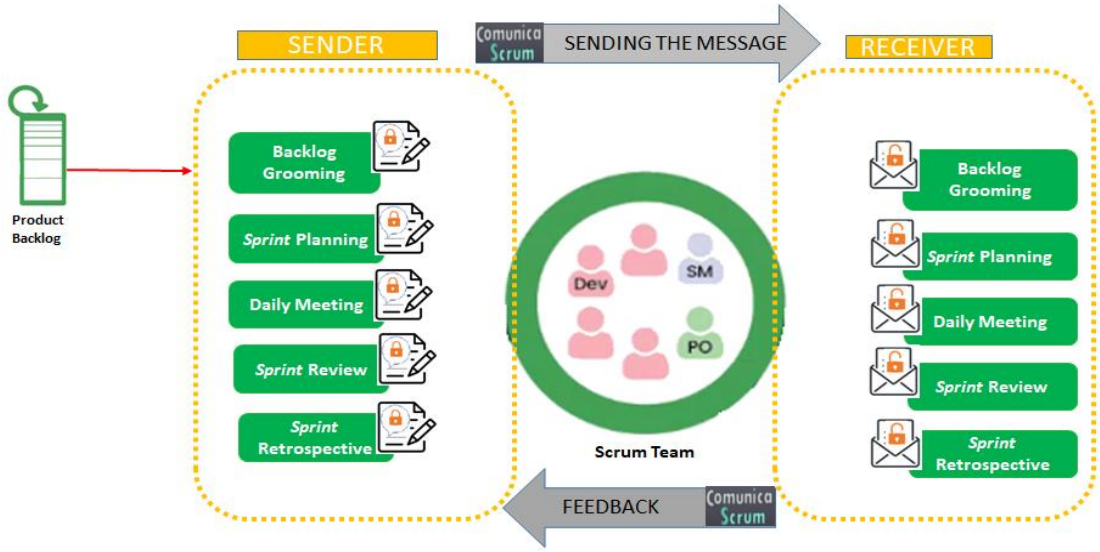

Fig. 3. Conceptual Diagram of the Proposed Solution.

In the context of Scrum, the main elements of the process are the user stories, which are recorded in the Product Backlog and are the basis for the execution of the different Scrum ceremonies. From these user stories and during the celebration of each Scrum ceremony, the messages that will be issued by the sender and transmitted through the communication channel are generated. Each message has a well-defined structure so that all parties involved can understand it. The dissemination of these messages is done through e-mail, instant messaging applications available among the team and through Comunica-Scrum, which is an application specifically designed for the generation of messages, understood as templates, which are used in the adaptation of Berlo's communication model to Scrum ceremonies. This tool has been developed with the purpose of systematizing and structuring the key information that is shared during each Scrum event, facilitating the codification and transmission of messages in a clear and uniform way. The application adapts precisely to the needs and dynamics of agile teams, allowing both the sender and receiver of the information to have an interface that acts as a communication channel, in line with the principles established by Berlo. In this context, Comunica-Scrum not only generates templates, but also contributes to the standardization and improvement of internal communication within the framework of the Scrum methodology. The implementation of these channels will facilitate the transmission of clear and structured messages, strengthening coordination and mutual comprehension between development teams and stakeholders.

Finally, the receivers interpret the message received according to the Scrum ceremony-taking place. When a message is not fully understood, the receiver can send a feedback message to the original sender, with the purpose of requesting clarification. In response, the sender provides the necessary information to resolve the request and ensure clear and effective communication.

Fig. 4 presents the application of the adapted Berlo communication model in the context of the Sprint Review Meeting, a fundamental ceremony within the Scrum framework where the development team and stakeholders evaluate the progress achieved against the objectives established for the Sprint. The Fig. 4 illustrates the structured flow of standardized messages, which includes the review of user stories committed to by the development team, their verification against acceptance criteria, as well as the feedback received and the corresponding adjustments to the Backlog. These messages are managed and transmitted through the Comunica-Scrum tool. This process ensures clear, coherent, and aligned communication among geographically distributed team members. This communicative structure contributes to overcoming inherent challenges in global environments, such as time zone differences and language barriers.

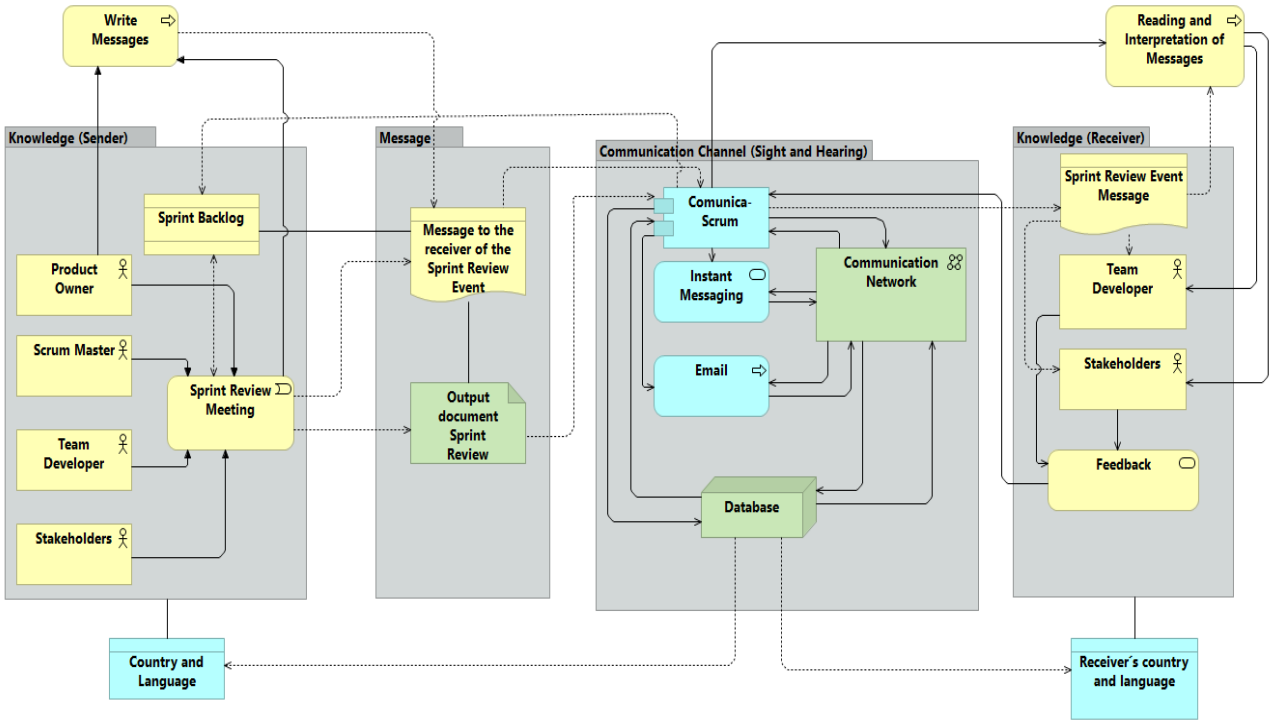

Fig. 4. Adaptation of the communication model (Sprint Review Meeting).

3.4 Development of the communication model

The messages generated in each of the Scrum ceremonies, together with the sender, the communication channel and the corresponding receivers, have been analyzed considering the five fundamental message components of Berlo's communication model: elements, code, structure, content and processing. These aspects are presented in detail in Table 2, providing a structured view of the communicative interaction within the Scrum framework.

Fig. 5 shows the template generated during the Sprint Review ceremony, which describes the messages sent and received by the sender and receiver, respectively. In turn, Fig. 6 presents an example of a feedback message, in which the receiver communicates with the original sender to clarify any doubts arising from the initial message transmitted during the Sprint Review.

The Sprint Review template collects the status of the user stories, the roles and the goal of the Sprint, i.e. the information (message content according to Berlo) and the structure that is presented during the Sprint Review in the development of a project. The data presented in this template was taken from a project in development for the creation of a Web application.

These messages include a detailed analysis of the comments and observations made by the interested parties, as well as the response of the original sender, whose purpose is to clarify the doubts raised by the recipient of the initial message. Content, which

covers the progress of user stories, completed tasks, and impediments, along with code or formatting, represented by a template with organized fields tailored to the Sprint Review ceremony, and structure, which defines the order in which information is presented within the template, make up the elements that allow the message to be codified and structured effectively.

Table 2. Correlation between Berlo Components and Scrum Ceremonies

Ceremonies	**Grooming**	**Planning**	**Daily**	**Review**	**Retrospective**
Sender	Product Owner	Product Owner	Team Developer	Product Owner	Scrum Master
Messages	1. Description of new features 2. Questions about stories, possible obstacles 3. Size and complexity of the stories 4. Work order of the stories	1. Prioritized User Stories 2. Feasibility analysis and questions 3. Sprint Tasks and Goals	1. What I did yesterday and what I will do today 2. Impediments detected 3. Reminder of objectives, unblocking of problems	1. Demonstration of completed work 2. Feedback on the Increment 3. Backlog adjustments based on feedback	1. Questions to analyze the Sprint 2. What went well, what to improve 3. Specific actions for the next Sprint
Elements	Refined user stories and agreements (HU)	Sprint planning and backlog breakdown	Sprint progress status, planning and barriers	Sprint status (HU completed, progress, estimates, story acceptance rate) and meeting results	Reflection on Sprint performance and suggestions for improvement
Code	Structured backlog format of the backlog, Scrum technical language, language	Scrum technical language, tabular structure, language	Scrum language, standard question structure, use of technical terminology, language	Technical language of Scrum, template structure and tables, language	Scrum language, standard retrospective structure, language
Structure	Clear organization of attendees, backlog, priorities, comments and general details (project, date, country, language)	Organization in sections: General information (project, date, country, language), attendees, backlog, tasks, objectives and comments	Clear organization in sections: General information (project, date, country, language), attendees, individual reports, barriers, planning	Clear organization in sections: General information (Project, date, country, language), attendees, backlog, objective, comments	Organization into sections: General information (project, date, country, language), attendees, reflections, opportunities for improvement
Content	Detailed user stories with acceptance criteria, estimates and priorities	Sprint Backlog with stories and tasks, developer assignments, estimates and targets	Activities completed, technical obstacles and planning for the next day	Sprint-specific data (completed stories, progress, estimates, comments)	Sprint evaluation, problem identification and definition of corrective actions
Treatment	Clear presentation through tables, prioritization and explanatory comments	Clear presentation through tables, use of priorities, and comments about the meeting	Brief and effective communication, with a homogeneous format to speed up the meeting	Optimized presentation with tables, structured comments and indicators	Clear and concise communication with a focus on continuous improvement
Channel	Comunica-Scrum,	Comunica-Scrum,	Comunica-Scrum,	Comunica-Scrum,	Comunica-Scrum,

	E-mail, Instant Messaging	E-mail, Instant Messaging	E-mail, Instant Messaging	E-mail, Instant Messaging	E-mail, Instant Messaging
Receiver	Team Developer, Stakeholders	Team Developer, Stakeholders	Team Developer, Scrum Master, Product Owner	Team Developer Stakeholders	Team Developer

The key factors considered in this message include various dimensions of effective communication within the Scrum framework. First, communication skills are essential to clearly and accurately express the reasons why user story HU005 was not completed. Therefore, the team's attitude plays a decisive role, reflecting the team members' willingness to address problems constructively focusing on continuous improvement. Knowledge or comprehension of the status of the user story and the development process is another key aspect, as it allows for an objective assessment of progress and decisions made. Furthermore, the team's social and cultural framework is reflected in established norms, agile values, and a culture of transparency, elements that foster team cohesion and efficiency. Feedback, provided by stakeholders who act as receivers, is essential for identifying areas for improvement and optimizing the process in later phases. In this sense, the feedback section within the template, specifically in the Response field, allows for two-way communication with the original sender. This encourages a transparent and collaborative flow of information aligned with the core principles of Scrum.

Project	**Web Application Development**							
Date & Time	03/03/2023 11:00							
Sprint n Review								
Country	United States							
Language	English							
Attendees	**Name**	**Role**	**Status**	**Assistants Type**				
	Jorge Hernández	Product Owner	Mandatory	Synchronous				
	Miguel López	Scrum Master	Mandatory	Synchronous				
	Juan Pérez	Developer Team	Mandatory	Synchronous				
	Humberto Suárez	Developer Team	Mandatory	Asynchronous				
	Pedro Páramo	Stakeholder	Optional	Synchronous				
	José Solano	Stakeholder	Optional	Asynchronous				
Sprint Backlog	**User Story**	**Name**	**Status**	**Acceptance Criteria**	**Progress**	**Estimated**	**Actual**	
	HU001	Implement user registration and authentication	Completed	YES	100%	16	16	
	HU002	Develop the main page of the platform	Completed	YES	100%	20	24	
	HU003	Main banner with representative image or video	Completed	YES	100%	16	20	
	HU004	Enable basic navigation between pages	Completed	YES	100%	8	16	
	HU005	Conduct unit tests	Incomplete	NO	83%	24	20	
					Total Hours:	84	96	
		Percentage of User Stories Accepted 80%			**Total Days:**	10.5	12	
Sprint Objective	Define the functional and non-functional requirements of the web platform, including design and usability features. This will allow us to establish a clear basis for the development of the project and ensure that it meets user expectations.							
Comments:	The implemented features do meet the needs of the target users. The web platform is easy to use, intuitive, and provides fluid user experience. The company's logos are missing.							

Fig. 5. Example of a Sprint Review Meeting Ceremony Message.

Project	Web Application Development						
Date & Time	04/03/2023 10:00						
Sprint n Review Feedback							
Country	United States						
Language	English						
Sender	Pedro Páramo	Stakeholder					
Receirve	Name	Role					
	Jorge Hernández	Product Owner					
Feedback	The user story HU005 was not completed						
Response	One of the tasks of User Story HU005 was poorly estimated, so it was not possible to finish this Sprint						

Fig. 6. Example of a Sprint Review Meeting Feedback Message.

3.5 Model validation using the Delphi method

The Delphi method, recognized as a structured forecasting technique that allows for the collection and consolidation of expert opinions through iterative and anonymous rounds aimed at achieving consensus (Almenara & Moro, 2014), was employed to validate the content of Berlo's communication model adapted to the Scrum methodological framework.

To this end, a questionnaire comprising 26 items was designed, with the purpose of assessing both the relevance and the wording of each question. Of these, thirteen items were intended to gather sociodemographic information from participants, including their professional experience, the type of organization in which they work, and the countries in which they operate. The remaining thirteen items focused on evaluating the applicability of the adapted model to Scrum ceremonies, with particular attention to the clarity, relevance, and effectiveness of its fundamental components: sender, message, channel, and receiver.

To facilitate the understanding of the model, experts were provided with an interactive presentation detailing the adaptation strategy, enabling them to become familiar with its key elements prior to completing the questionnaire.

The relevance and clarity in the wording of the questionnaire items were evaluated using the Delphi method, with the participation of a panel consisting of ten experts—eight specialized in software development and two in statistics—across two rounds of feedback. In the first round, the items were subjected to review and analysis, yielding *Aiken's V* coefficients above 0.85 for the majority of the questions, with items P7, P13, and P16 standing out for achieving an almost unanimous consensus with a value of 0.972.

Conversely, items P3, P12, P17, and P19, primarily related to the clarity of the question wording, recorded coefficients below 0.8, which prompted their revision and adjustment during the second round of the process. These modifications were aimed at enhancing linguistic precision and strengthening the alignment of the items with the objectives of the proposed communication model.

Based on the feedback obtained, modifications were made to the instrument, including restructuring questions and improving their wording to avoid ambiguities. After addressing the initial observations, the survey was sent back to the panel of experts to validate the adjustments made. The experts expressed their agreement with both the observations addressed and the questions in the measurement instrument, positively evaluating its relevance and wording. This iterative process allowed for the refinement of the instrument, ensuring that the questionnaire was clear, relevant, and representative of the theoretical construct being evaluated.

The results reflected an improvement in the *Aiken V* coefficient, particularly in the wording of items P3, P12, P17 and P19, which were adjusted according to the recommendations received. Most items achieved values above 0.8, indicating a high level of agreement regarding the wording. The final analysis confirmed a high concordance in the relevance and wording of the items, which justified the application of the instrument to professionals in the software development area.

3.6 Application of the instrument to professionals in software development under Scrum

Once the instrument validation process was completed, it was emailed to a group of Scrum software development professionals to gather data on their perceptions of the adapted model's content.

Participant selection: The study focused on software development companies that implement agile methodologies, particularly the Scrum framework, in distributed team environments. The population under analysis included organizations where communication plays a crucial role in project coordination and success. The sample, composed of 44 professionals from seven countries, was representative of a global work environment, as it included participants operating in different geographic regions and speaking different languages. The analysis unit was distributed by Scrum teams, evaluating their communicative effectiveness.

Survey application: The instrument was distributed in digital format via email and participants were asked to respond based on their professional experience and their interaction with Scrum teams in GSD environments.

Sampling*:* A non-probability intentional sampling was used, selecting professionals with experience in Scrum and distributed software development; these professionals met the requirements necessary to evaluate the effectiveness of the communication model proposed in this study.

Design types: The design of the present study was non-experimental, since it does not involve the manipulation of variables, but rather focuses on the observation and measurement of the effectiveness of communication in distributed teams. The data collection technique involved the use of surveys as an instrument to gather quantitative information regarding participant experiences and to assess communicative effectiveness within the context of distributed Scrum teams. This approach provided an objective and detailed view of the phenomenon studied, providing a basis for identifying strengths and areas for improvement in the interaction of these teams.

Instrument: The instrument used was a questionnaire that used Likert-type scales to evaluate participants' perceptions of the proposed model.

Reliability of the Assessment Instrument**:** The reliability of the questionnaire titled “Evaluation of the Berlo Communication Model Applicable to the Scrum Framework in a Global Software Development Environment”, administered to software development professionals working under Scrum, and was assessed using *Cronbach’s Alpha* coefficient, a widely recognized measure of internal consistency (Tavakol & Dennick, 2011). The instrument, composed of 26 items divided into two sections—sociodemographic and model evaluation—was analyzed by considering only the questions aimed at evaluating the effectiveness of the adapted Berlo communication model, excluding those from the sociodemographic section.

The calculation of *Cronbach’s Alpha* yielded a value of 0.862, indicating high internal consistency (values between 0.8 and 0.9 are considered robust). This result confirms that the items are homogeneous and reliably measure the effectiveness of the model without significant redundancy. The analysis was conducted using statistical software to compute inter-item correlations based on the responses of 44 professionals from seven countries, ensuring the robustness of the instrument for evaluating the model in distributed Scrum teams.

3.7 Analysis of the Results from the Instrument Application

The analysis of the survey results, in relation to the participating companies, showed the predominance of the commercial sector, which represented 56.8% of the cases, followed by the service sector (20.5%), while the industrial, retail and educational sectors had a participation of less than 5% each. In terms of geographic origin, 77.3% of respondents work in Mexican companies, followed by the United States (6.8%), Spain and India (4.5% each), and other countries such as Costa Rica, England and Colombia (2.3% each), reflecting the diversity of time zones and languages within the study. Regarding communication languages, Spanish was the most used language by 97.7% of participants; however, 34.1% also used English or other languages, which presents a challenge in multilingual environments. Regarding company size, 65.9% of respondents work in large companies with more than 100 employees, 20.5% in medium-sized companies, 9.1% in small businesses, and 4.5% in micro-enterprises, demonstrating that the Scrum framework is applied in organizations of various sizes.

Analysis of the survey results, in relation to industry professionals, revealed that 38.6% of respondents work in companies with more than 100 developers, while 25% belong to teams of 1 to 10 people, another 25% to teams of 11 to 50 members, and 11.4% to teams of 51 to 100 members, confirming Scrum's adaptability to teams of various sizes. In terms of positions held, most participants work as software developers (77.3%), followed by project leaders (6.8%), project managers and testers (4.5%), and 2.3% in roles such as UX designers, business analysts and software architects. Regarding their role within Scrum, 86.4% indicated that they are part of the development team, 9.1% act as Scrum Master, and 4.5% as Product Owner. In terms of professional experience, 54.5% of respondents have between 0 and 5 years in software development, 31.8% between 6 and 10 years, 11.4% between 11 and 20 years, and only 2.3% have more than 20 years of experience in the sector. Regarding specific experience with Scrum, 81.8% have worked with this methodology for 0 to 5 years, 15.9% between 6 and 10 years, and only 2.3% have accumulated more than 20 years of experience using it. Finally, the professionals surveyed have participated in both local and distributed projects, with an emphasis on distributed environments, reinforcing the importance of effective communication models in global agile teams. Fig. 7 presents the distribution of respondents by geographic origin and Scrum roles, reflecting the proposed model's global applicability and specificity by role.

Model evaluation. A set of questions was presented to software development professionals who use the Scrum framework, see Table 3, with the aim of validating the developed communication model. These questions were designed taking the experience and knowledge of the participants into account, with the purpose of ensuring the applicability and effectiveness of the model in distributed teams under the Scrum framework. The feedback obtained enabled the identification of potential adjustments to optimize communication, thereby enhancing coordination and efficiency in project execution.

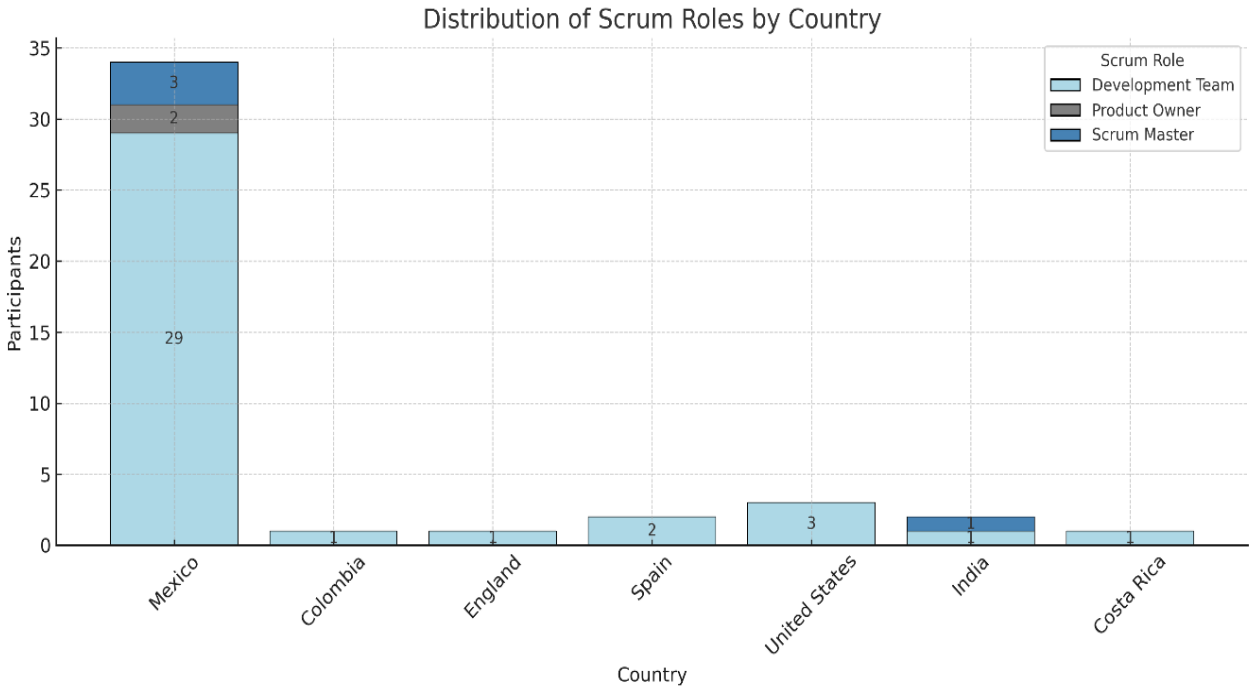

Fig. 7. Distribution of Participants by Geographic Origin and Scrum Role.

Table 3. Questions to Assess the Implementation of the Communication Model in Scrum Environments

Number	Question
P1	To what extent do you think the proposed communication model can improve communication in your team?
P2	The information generated at each ceremony will be sent to everyone involved, even if they do not attend the meetings due to time differences or other circumstances. To what extent do you think this will improve communication between them?

P3	The information generated in each of the ceremonies will be sent to each of those involved in the language of each of the receivers. Do you think this will improve communication between them?
P4	Do you think there is any benefit to keeping track of messages sent, indicating whether the receivers have understood them?
P5	Could the implementation of the proposed communication model through an application help ensure that the messages transmitted in Scrum ceremonies reach all participants in a timely and complete manner, optimizing communication within your team?
P6	Can the frequency of messages sent and received promote feedback to improve communication among staff in distributed teams?
P7	Do you believe that the proposed communication model could enhance the clarity and comprehension of messages?
P8	Do you think that collaboration within the Scrum team can be improved, once the proposed communication model is used?
P9	Will there be an improvement in access to information, once the proposed communication model is used?
P10	Do you think that feedback can be improved once the proposed communication model is used?
P11	Do you think using templates for messaging and feedback can improve communication once the proposed model is used?
P12	Are the communication channels used—Communicates-Scrum, email, and an instant messaging app—appropriate for the type of information being shared?
P13	Would you recommend the proposed communication model to other Scrum teams?

This analysis integrated content validation, ensuring that the instrument not only reflects the theoretical foundations of Berlo's model but also remains relevant within the context of agile practices. The participation of professionals in the area allowed progress in the evaluation of the instrument, confirming its reliability for the study. Furthermore, the data collected enabled the analysis of key aspects of effective communication in distributed teams, providing relevant information for its application in agile environments.

Suggestions for optimizing the model. Based on the observations of experts in the development of software projects under the Scrum framework, the results of the analysis were used to make final adjustments to the model and consolidate its applicability in real projects.

4 Results

This section presents the results obtained from the application of the instrument used to evaluate software development professionals' perceptions of the proposed communication model based on Berlo's framework. The survey, administered to 44 experts from seven countries, assessed the perceived effectiveness of the model in enhancing communication within distributed Scrum teams. While these findings indicate strong professional support for the model's applicability, further case studies in real-world environments are necessary to validate empirically its impact on project outcomes.

Table 4 provides a summary of the descriptive statistics derived from the survey responses of 44 professionals experienced in software development under the Scrum framework. Measures such as mean, median, mode, standard deviation, and variance are included to analyze central tendency and response dispersion. The results reveal that the responses reflect predominantly positive perceptions, with ratings primarily concentrated around values of 4 and 5 across most evaluated items.

The mean response values ranged from 4.136 to 4.591, with question P5 obtaining the highest average, suggesting particularly favorable feedback in that area. The median and mode support this trend, showing values of 4 or 5 for most items. Additionally, the standard deviation ranged from 0.542 to 0.780, indicating moderate variability and suggesting a reasonable level of consensus among respondents.
In summary, the survey results allowed us to conclude that software development professionals positively assessed the application of Berlo's communication model adapted to Scrum teams in Global Software Development contexts.

Table 4. Descriptive statistics of the survey

Question	Average	Standard deviation	Variance	Median	Mode	Minimum	Maximum
P1	4.136	0.668	0.446	4	4	3	5
P2	4.205	0.594	0.353	4	4	3	5
P3	4.432	0.728	0.530	5	5	3	5
P4	4.364	0.780	0.609	5	5	2	5
P5	4.591	0.542	0.294	5	5	3	5
P6	4.409	0.542	0.294	4	4	3	5
P7	4.409	0.542	0.294	4	4	3	5
P8	4.500	0.550	0.302	5	5	3	5
P9	4.432	0.587	0.344	4	4	3	5
P10	4.523	0.549	0.302	5	5	3	5
P11	4.455	0.663	0.440	5	5	3	5
P12	4.205	0.765	0.585	4	4	2	5
P13	4.386	0.538	0.289	4	4	3	5

Regarding the specific objectives of the study, each was evaluated through targeted questions, and the analysis of the responses highlighted the model's effectiveness in improving communication within distributed teams. The findings corresponding to each objective are detailed in Table 5, based on the respondents' answers. This structured evaluation provides a clearer understanding of how each component of the model contributes to improved communication. The high levels of agreement among respondents further support the model's relevance in real-world Scrum environments.

Table 5. Analysis of the Study's Specific Objectives and Associated Survey Responses

Objective	Associated Questions	Key Findings from Analysis	Model Evaluation Summary
1. Ensure that the messages generated in each of the Scrum ceremonies are received by those involved	P2, P5, P9, P12	P2: 90.9% believe that sharing info with all, even non-attendees, improves communication (supports overcoming time zones). P5: 97.7% support using an app to transmit ceremony messages. P9: 95.4% recognize challenges in distributed teams. P12: 88.7% agree the model improves access to information and fits well with proposed communication channels	The model enhances message delivery across distances and makes use of appropriate channels (Comunica-Scrum, email, messaging) to ensure access and overcome geographic/time constraints
2. Verify that the received messages are understood in their structure and content in the receiver's language	P3, P4, P7, P11	P3: 86.3% think communication improves when messages are in the receiver's language. P4: 85.8% see benefits in monitoring message comprehension. P7: 97.7% agree the model improves understanding and message clarity. P11: 91.9% value standardized templates for clear communication	The model supports clear message comprehension via translation, standardized templates, and monitoring, which minimizes misunderstandings and promotes clarity in distributed teams

3. Provide feedback on the comprehension of the messages analyzed by the participants involved	P6, P8, P10	P6: 97.7% say frequent messaging promotes effective feedback. P8: 97.8% agree that the model improves collaboration. P10: 97.7% state the model facilitates better feedback and discussion	The model fosters continuous feedback, promoting collaboration, message understanding, and resolution of communication issues within Scrum teams

5 Discussion

Effective communication is a fundamental pillar for the success of distributed teams using agile methodologies such as Scrum. However, global teams face significant challenges, such as cultural, linguistic, and technological barriers, as well as differences in time zones and organizational practices, which hinder the efficient flow of information. In this context, the communication model, based on an adaptation of Berlo's model, was analyzed and compared with empirical studies in the field of GSD.

The proposed communication model improves the accessibility of messages for all those involved, even in the absence of their direct participation in meetings, by integrating an automated system, email and instant messaging applications. Furthermore, it incorporates automatic translation into the target language, which improves inclusion and participation within distributed teams. This approach aligns with the findings of Bhatti and Ahsan (2017), who emphasize the critical role of stakeholder engagement and acculturation in achieving effective communication.

The evaluation of the content of the model proposed here indicated that the implementation of controls to verify the understanding of critical messages and the use of standardized templates achieved acceptance rates of 85.8% and 91.9%, respectively. These results suggest that the model can facilitate improved communication, particularly in situations of changing requirements, where message clarity is essential. In comparison, the conceptual model developed by Qureshi et al. (2021) achieved an 87% effectiveness rate. However, the model proposed here incorporates a more comprehensive approach, including continuous monitoring of understanding, allowing it to be adapted to the specific needs of distributed Scrum teams.

According to the evaluation of the content of the model presented in this study, it was indicated that the integration of communication channels adapted to the workflow proposed in the model could contribute to mitigating the cultural and technological challenges that arise in the development of software projects. These strategies can improve both accessibility and clarity in communication, reaching acceptance rates of 88.7% and 95.4%, respectively. In line with this, Šmite et al. (2021) identified that cultural differences and inadequate use of tools hinder the implementation of Scrum in distributed environments. The model proposed here responds to these challenges by integrating machine translation and inclusive strategies, promoting effective and adaptive communication in distributed teams.

Another highlight of the model's content evaluation was the improvement in the frequency and clarity of messages, which can foster continuous feedback and effective collaboration, achieving acceptance rates of 97.7% and 97.8%, respectively. These results support the model's ability to strengthen self-organization in distributed teams, an aspect emphasized by Hidalgo (2019) in his analysis of the application of Scrum in scientific settings. While requiring flexible adaptations, the model strengthens coordination within teams through a systematic approach to effective communication, ensuring structured interaction aligned with agile principles.

Although the proposed communication model facilitates comprehension and feedback among team members through templates, it does not automatically generate the creation of other types of documentation required for each ceremony. According to Alzoubi and Gill (2021), the lack of adequate documentation is a critical challenge in distributed teams, affecting the clarity and continuity of projects. Integrating specific strategies to document the information generated would strengthen the model, optimizing knowledge management and efficiency in global teams.

6 Conclusions

According to the respondents' perception, the proposed communication model—based on the adaptation of Berlo's SMCR framework to distributed teams using the Scrum methodology—demonstrates high feasibility for addressing communication

challenges in Global Software Development (GSD) environments. This assessment was derived from a survey conducted with 44 professionals from seven countries, whose reliability was supported by a *Cronbach's Alpha* coefficient of 0.862, indicating strong consistency in the responses. Based on this validation, participants believe that the model has the potential to generate the following improvements in communication management: 1*) Improved message accessibility*; messages generated during Scrum ceremonies reach all stakeholders, including those unable to attend meetings due to time zone differences. This was confirmed by 90.9% of respondents, who acknowledged improved communication through automated distribution via the Comunica-Scrum application, email, and instant messaging; 2) *Greater message clarity and comprehension*; the incorporation of standardized templates and translation into the receiver's language could facilitate clearer and more accurate communication. A total of 97.7% of participants agreed with this statement, suggesting a significant improvement in message understanding; 3) *Strengthened feedback loops*; the model has the potential to promote continuous feedback by fostering collaboration and shared understanding among development team members. This statement is supported by 97.7% of respondents, who perceived improvements in feedback mechanisms; 4) *Mitigation of cultural and linguistic barriers;* automatic translation and structured templates may help overcome language and cultural challenges. This approach was valued by 86.3% of respondents, who emphasized the benefits of more effective multilingual communication; 5) *Optimized coordination in distributed teams*; the integration of the Comunica-Scrum application could enhance team coordination by ensuring the timely and complete delivery of messages. This assertion was endorsed by 97.7% of participants, who recognized its effectiveness in communication management.

These findings suggest that the proposed model is feasible for strengthening collaboration and coordination in distributed agile projects by improving communication and addressing key challenges such as language barriers and time zone differences. However, as the model's validation was based on expert opinion rather than full-scale implementation, its effectiveness in real software development environments still needs to be verified. Therefore, future research should focus on case studies that evaluate its practical impact, as well as the adoption of technological tools such as Comunica-Scrum in diverse organizational contexts.

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References

Almenara, J. C., & Moro, A. I. (2014). Empleo del método Delphi y su empleo en la investigación en comunicación y educación. *Edutec, Revista Electrónica de Tecnología Educativa*, *48*, Article 48. https://doi.org/10.21556/edutec.2014.48.187

Alsaqaf, W., Daneva, M., & Wieringa, R. (2019). Quality requirements challenges in the context of large-scale distributed agile: An empirical study. *Information and Software Technology*, *110*, 39–55. https://doi.org/10.1016/j.infsof.2019.01.009

Alzoubi, Y., & Gill, A. (2021). The Critical Communication Challenges Between Geographically Distributed Agile Development Teams: Empirical Findings. *IEEE Transactions on Professional Communication*, *64*(4), 322–337. IEEE Transactions on Professional Communication. https://doi.org/10.1109/TPC.2021.3110396

Alzoubi, Y. I., Gill, A. Q., & Al-Ani, A. (2016). Empirical studies of geographically distributed agile development communication challenges: A systematic review. *Information & Management*, *53*(1), Article 1. https://doi.org/10.1016/j.im.2015.08.003

Ammad, G., Iqbal Janjua, U., Madni, T. M., Cheema, M. F., & Shahid, A. R. (2019). An Empirical Study to Investigate the Impact of Communication Issues in GSD in Pakistan's IT Industry. *IEEE Access*, *7*, 171648–171672. IEEE Access. https://doi.org/10.1109/ACCESS.2019.2953008

Baecker, D. (2017). Teorías sistémicas de la comunicación. *Revista Mad. Revista del Magíster en Análisis Sistémico Aplicado a la Sociedad*, *37*, Article 37.

Bannerman, P. L., Hossain, E., & Jeffery, R. (2012). Scrum Practice Mitigation of Global Software Development Coordination Challenges: A Distinctive Advantage? *2012 45th Hawaii International Conference on System Sciences*, 5309–5318. https://doi.org/10.1109/HICSS.2012.512

Beck, K., Beedle, M., Bennekum, A. V., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). *Manifesto for Agile Software Development*. http://agilemanifesto.org/iso/en/manifesto.html

Berlo, D. K. (1984). *El proceso de la COMUNICACIÓN, Introducción a la teoría y la práctica* (14°). EL ATENEO.

Bhatti, M. W., & Ahsan, A. (2017). Effective Communication among Globally Distributed Software Development Teams: Development of an "Effective Communication" Scale. *Journal of Global Information Management (JGIM)*, *25*(3), Article 3. https://doi.org/10.4018/JGIM.2017070103

Braddock, R. (1958). An Extension of the "Lasswell Formula". *Journal of Communication*, *8*(2), 88–93. https://doi.org/10.1111/j.1460-2466.1958.tb01138.x

Bundhun, K., & Sungkur, R. K. (2021). Developing a framework to overcome communication challenges in agile distributed teams – Case study of a Mauritian-based IT service delivery centre. *Global Transitions Proceedings*, *2*(2), Article 2. https://doi.org/10.1016/j.gltp.2021.08.006

DeFranco, J. F., & Laplante, P. A. (2017). Review and Analysis of Software Development Team Communication Research. *IEEE Transactions on Professional Communication*, *60*(2), Article 2. IEEE Transactions on Professional Communication. https://doi.org/10.1109/TPC.2017.2656626

El-Najar, T., Ahmad, I., & Alkandari, M. (2019). Easycomm—A Framework and Tool to Solve Client Communication Problem in Agile Development. *IAENG International Journal of Computer Science*, *46*.

Hernández-Bravo, J. M., Valenzuela-Robles, B. D., Santaolaya-Salgado, R., Rojas-Pérez, J. C., Fragoso-Díaz, O. G., Castro-Sánchez, N., & Gómez-Álvarez, M. C. (2022). Proposal for an adaptation of a Strategic communication model applicable to the Scrum framework in a GSD environment. *2022 11th International Conference On Software Process Improvement (CIMPS)*, 74–84. https://doi.org/10.1109/CIMPS57786.2022.10035695

Hidalgo, E. S. (2019). Adapting the scrum framework for agile project management in science: Case study of a distributed research initiative. *Heliyon*, *5*(3), Article 3. https://doi.org/10.1016/j.heliyon.2019.e01447

Hossain, E., Bannerman, P. L., & Jeffery, D. R. (2011). Scrum Practices in Global Software Development: A Research Framework. En D. Caivano, M. Oivo, M. T. Baldassarre, & G. Visaggio (Eds.), *Product-Focused Software Process Improvement* (pp. 88–102). Springer. https://doi.org/10.1007/978-3-642-21843-9_9

Kostin, D., & Strode, D. (2023). Effective Communication in Globally Distributed Scrum: A Model and Practical Guidance. *Australasian Journal of Information Systems*, *27*. https://doi.org/10.3127/ajis.v27i0.4501

Luz, M., Gazineu, D., & Teófilo, M. (2009). *Challenges on Adopting Scrum for Distributed Teams in Home Office Environments*. *3*(11).

Maletzke, G. (1992). *Psicología de la Comunicación Social* (5a.). QUIPUS.

Noor, H., Hayat, B., Amjad, Z., Hanif, M., Tabussum, S., Mansha, R., & Mubasher, K. (2021). Identifying Communication Issues Contributing to the Formation of Chaotic Situation: An AGSD View. *International Journal of Advanced Computer Science and Applications*, *12*. https://doi.org/10.14569/IJACSA.2021.0120268

Pilshchikov, I. (2021). El esquema comunicativo de Roman Jakobson entre lenguas y continentes: Historia cruzada del modelo teórico. *Revista de Estudios Sociales*, *77*, Article 77. https://doi.org/10.7440/res77.2021.01

Qureshi, S., Khan, S. U. R., Inayat-Ur-Rehman, Javed, Y., Saleem, S., & Iqbal, A. (2021). A Conceptual Model to Address the Communication and Coordination Challenges During Requirements Change Management in Global Software Development. *IEEE Access*, *9*, 102290–102303. IEEE Access. https://doi.org/10.1109/ACCESS.2021.3091603

Santos, R. D. S., Ralph, P., Arshad, A., & Stol, K.-J. (2023). Distributed Scrum: A Case Meta-analysis. *ACM Computing Surveys*, *56*(4), 100:1-100:37. https://doi.org/10.1145/3626519

Schramm, W. (1972). *The Process and Effects of Mass Communication*. University of Illinois Press.

Serrano, J. C., & Zapico, F. A. (2004). La fórmula de comunicación de Lasswell como método para implementar bases de datos documentales en los medios audiovisuales. *Investigación Bibliotecológica: archivonomía, bibliotecología e información*, *18*(37), Article 37. https://doi.org/10.22201/iibi.0187358xp.2004.37.4048

Shafiq, S., Hafeez, Y., Ali, S., Iqbal, N., & Jamal, M. (2019). Towards Scrum Based Agile Framework for Global Software Development Teams. *Mehran University Research Journal of Engineering and Technology*, *38*(4), Article 4. https://doi.org/10.22581/muet1982.1904.11

Shameem, M., Kumar, R. R., Nadeem, M., & Khan, A. A. (2020). Taxonomical classification of barriers for scaling agile methods in global software development environment using fuzzy analytic hierarchy process. *Applied Soft Computing*, *90*, 106122. https://doi.org/10.1016/j.asoc.2020.106122

Šmite, D., Moe, N. B., & Gonzalez-Huerta, J. (2021). Overcoming cultural barriers to being agile in distributed teams. *Information and Software Technology*, *138*, 106612. https://doi.org/10.1016/j.infsof.2021.106612

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Yagüe, A., Garbajosa, J., Díaz, J., & González, E. (2016). An exploratory study in communication in Agile Global Software Development. *Computer Standards & Interfaces*, *48*, 184–197. https://doi.org/10.1016/j.csi.2016.06.002