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BUSTECH 2024 Editors

Pascal Lorenz, University of Haute-Alsace, Colmar, France

BUSTECH 2024

Forward

The Fourteenth International Conference on Business Intelligence and Technology (BUSTECH 2024), held on April 14 – 18, 2024, continued a series of events covering topics related to business process management and intelligence, integration and interoperability of different approaches, technology-oriented business solutions and specific features to be considered in business/technology development.

Similar to the previous edition, this event attracted excellent contributions and active participation from all over the world. We were very pleased to receive top quality contributions.

We take here the opportunity to warmly thank all the members of the BUSTECH 2024 technical program committee, as well as the numerous reviewers. The creation of such a high quality conference program would not have been possible without their involvement. We also kindly thank all the authors that dedicated much of their time and effort to contribute to BUSTECH 2024. We truly believe that, thanks to all these efforts, the final conference program consisted of top quality contributions.

Also, this event could not have been a reality without the support of many individuals, organizations and sponsors. We also gratefully thank the members of the BUSTECH 2024 organizing committee for their help in handling the logistics and for their work that made this professional meeting a success.

We hope BUSTECH 2024 was a successful international forum for the exchange of ideas and results between academia and industry and to promote further progress in the area of business intelligence and technology. We also hope that Venice provided a pleasant environment during the conference and everyone saved some time to enjoy this beautiful city.

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Table of Contents

Leveraging Data-Driven Approach to Empower Assistive Technology

Sabin Nakarmi, Karim Ouazzane and Dr. Qicheng Yu
School of Computing and Digital Media
London Metropolitan University
London, UK
email: {n.sabin, k.ouazzane, q.yu}@londonmet.ac.uk

Manmeet Gill, Sanjana Khemka
Product Department
Filisia Interfaces Ltd
London, UK
email: {manmeet, sanjana}@filisia.com

Abstract — **Assistive technology plays an important role in aiding people with Special Educational Needs and Disabilities (SEND). Filisia Interface Ltd has successfully developed an award-winning assistive hardware (COSMO), which is being used in schools, therapy, and homes to aid in learning for users with SEND. However, interoperability and integration with existing systems to ensure compatibility and smooth data exchange and personalization and adaptability are among key challenges in developing assistive technology. This research paper explores how a data-driven approach can be leveraged to empower the emerging potential of assistive technology and its impact on EdTech. The paper investigates how assistive technology is being used and the limited options for customizations and personalization for individuals with different physical or cognitive conditions. Also, this paper highlights how key metrics from the COSMO assistive hardware are used alongside its partner application to create an integrated system that processes and visualizes this data for interpretation by therapists and teachers for progress tracking purposes. The first version of the system has been deployed and is in its user evaluation stage which has been very well received.**

Keywords- assistive technology; EdTech; Special Educational Needs and Disabilities (SEND); progress tracking.

I. INTRODUCTION

The term Assistive Technology refers to a wide spectrum of tools, devices, and software that aid in communicative, sensory, physical, or cognitive function for individuals with special requirements [1]. Beyond its various applications and advancements in the technological field, it plays a much more important role in promoting accessibility, equal opportunity and creating a more inclusive environment. Its importance in the modern world stems from its ability to close the gap between ability and access. The usage of assistive technology in domains such as education, employment, or even just as an aspect of daily life can help people with disabilities to be active participants in their respective activities and improve social interactions.

In EdTech, technologies like speech recognition, gaze tracking, and collaborative learning insights further enrich the learning environment, ensuring an inclusive and effective educational experience [11]. Assistive technology for Special Educational Needs and Disabilities (SEND) plays a crucial role in promoting inclusive education, enhancing learning experiences, and empowering individuals with diverse abilities. This technology encompasses a wide range of tools, devices, software, and strategies that help individuals overcome barriers and participate fully in educational activities [2]. That being said, extensive ethical considerations are vital, ensuring data privacy and security while leveraging data to empower students with disabilities and foster equitable learning outcomes [3]. In addition to that, some major concerns in the current assistive technology market were discovered.

1. Personalization and customization: Most available assistive technologies were found to be developed for specific conditions hindering effectiveness in scenarios with a wide spectrum of conditions [4].
2. Lack of research and development: There may be disability-specific needs that are overlooked during the development of assistive technologies due to insufficient research into the condition [5].

This study was conducted alongside Filisia Interfaces Ltd and the assistive technology and application they developed. The company specializes in developing assistive technology products and solutions, particularly for individuals with special educational needs and disabilities. The product (COSMO) is a combination of assistive hardware and custom-built software that acts as a learning environment.

The focus of this paper is on how a data-driven approach can add to the functionality of assistive technology to track the progress of users with SEND, aid in adaptive gaming, and possibly help with pattern recognition of specific markers to differentiate various communicative, sensory, physical, or cognitive conditions. By doing so, this study also aims to bring COSMO into focus and how it addresses the gaps in the current assistive technology market.

The rest of this paper is organized as follows. Section II explores the use cases and similar studies that have been conducted on topics concerning data and assistive technologies. Section III describes the work performed for this research paper using the COSMO devices and the methodology, development, and implementation of data-driven software. Section IV addresses the content that is visualized using graphs and how it can be interpreted to facilitate progress tracking. Section V talks about possible work in progress or additional aspects of the topics to be added and finally close the article.

II. RELATED WORKS

Assistive technology is by no means a new topic of research as their application can be seen in various domains and there have been numerous studies and case studies detailing the research and development that has been carried out towards the improvement of the technology, as well as understanding the conditions of the users [1][6]. A comprehensive literature review has been performed to

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understand how assistive technology is being used, its implications, and the challenges it has faced. This research also sheds light on how the process of research and development of assistive technology has been carried out collaboratively with the private sector [6]. To that extent, this section will detail some of the pertinent papers and articles relevant to the topic at hand.

To start with, collaborative research conducted by Filisia Interfaces Ltd and the University of Birmingham discovered that technology-assisted music-making can have a positive impact in enhancing engagement and social interaction in children with Autism [7]. This study used the COSMO buttons and specific music-based activities provided by the company to test the social-emotional communication and response, attentiveness, and engagement of a group of children with Autism. It deducted that in this scenario, using sounds alongside assistive hardware showed positive outcomes [8].

Similarly, the thesis "Using Wearable Assistive Technology to Improve Time Management of Students with Disabilities in a School-Based Employment Training Setting" [9] and the experiments conducted suggest that using wearable assistive technology in the form of smartwatches (Apple Watch) can help students with disabilities function with a higher degree of attention and improved time management. This thesis goes on to signify the usefulness of assistive technology and the socio-economic impacts it can have by making students with disabilities more employable.

Another research paper, "Augmented Learning Environments as Assistive Technology for Kids with Learning Disabilities" [10] shows the effects of creating a learning environment augmented by assistive tech and the benefit it has for teaching kids with learning disabilities.

III. ASSISTIVE TECHNOLOGY IN ACTION

This section elaborates upon how the assistive technology developed by Filisia Interfaces is being used in schools and therapy, the methodology behind progress tracking using COSMO and how it was implemented.

A. Use of COSMO in EdTech and Therapy.

The symbiotic relationship between data and the decision-making process has been observed throughout various industries and domains over a long period of time. Companies and organizations are increasingly relying on data to make critical choices for themselves. Data also serves a pivotal role in augmenting educational technology with assistive capabilities. By utilizing data, educational technology can tailor learning experiences to the individual needs of students with disabilities. This includes personalized learning paths that adapt content and pacing, early intervention through data-driven identification, and real-time progress monitoring. Furthermore, assistive technology can be utilized to analyze data, adapt instructional materials for accessibility, and provide immediate feedback, enhancing engagement and skill acquisition.

With the target of creating an inclusive learning environment, assistive technology plays an integral role in EdTech. There are diverse learning conditions in a SEND environment and assistive technology bridges the gap between various kinds of learning. One such hardware, a Bluetooth-enabled switch COSMO also known as Cosmoids developed by Filisa Interfaces Ltd can work alongside an iOS application to give access to multiple training and learning activities, or each Cosmoid can be customized to register a keystroke to control 3rd party devices and apps. This functionality provides an added benefit to the use case of this device as being able to use the buttons as switches for keyboards can help people with disabilities requiring less external support and improve their confidence [12]. The company works with various Occupational Therapists and schools where these devices are used in therapy and educational settings.

When used with the iOS application, up to 6 cosmoids can be connected concurrently to be used with various activities. Each cosmoid is represented with different colors for identification and tracking. The iOS application gives access to various activities which range from simple cause-and-effect to math. The devices also consist of dynamic touch and force sensors which are used for this experiment to collect data on how quickly a user can press the button and how hard they press the button after a visual cue is provided.

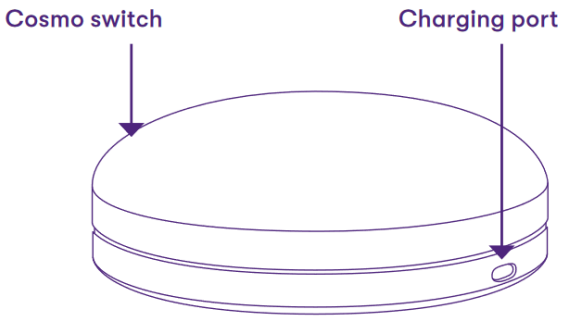

Figure 1. Cosmoid Top View.

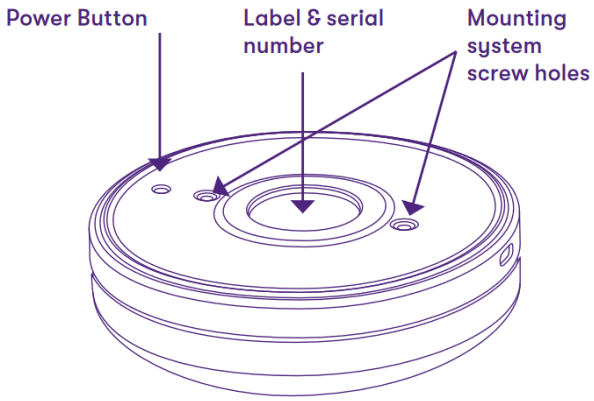

Figure 2. Cosmoid Bottom View.

Figure 1 and Figure 2 show the Cosmoid button/switch in which its outer hardware specification is detailed from the top and the bottom, respectively.

B. Methodology: Progress Tracking using COSMO

The cosmoids work in conjunction with the iOS application (Cosmo Training) to provide various activities to the users. One such activity – Sequence, was developed from scratch with its data insights being useful for both the company and the user. The core concept for this activity came from discussions on how the hardware and data generated from it can be integrated with a therapy session and the kind of interpretation that can be extrapolated to aid in the progress tracking of a patient.

To that end, the activity was designed with various predefined configurations to minimize the external factors that could skew the measurements of the experiment, but users are still given the flexibility to create custom configurations as they see fit. The predefined configurations consider the number of devices, the duration of the session and distance between the devices to ensure the experiments generate consistent data. In an experiment the following key metrics are collected so that it may be used in progress tracking:

1. Number of Trials: The number of times in an experiment where a sequence of all devices was pressed.
2. Total Duration: The time the experiment was conducted.
3. Response Times: The time it took to press each cosmoid in each trial. This value is later used to calculate the average response time for each cosmoid.
4. Force Values: The force with which each cosmoid was pressed in each trial. This value is later used to calculate the average force value for each cosmoid.

Other metrics are also tracked and collected for processing, but the above-mentioned metrics are key for interpreting progress in a patient.

C. Implementation of solution

The proposed solution which is implemented in this paper is visualized in Figure 3. In the workflow, the data generated by the cosmoids is stored using the existing iOS application (Cosmo Training) along with other user data into a NoSQL database (Cloud Firestore) in this instance and utilize the serverless capabilities provided by the Google Cloud Platform to execute the necessary processing of the data and the generation of the visualizations. At the same time, the iOS app also sends the data to a third-party analytics platform which is used for reports and insights necessary for internal decision-making.

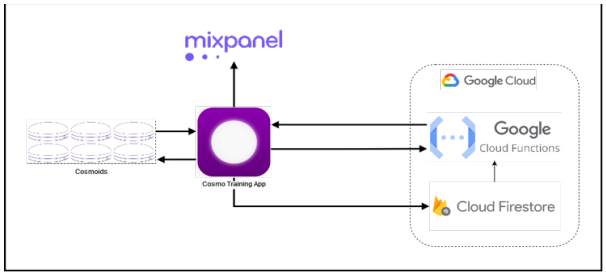

Figure 3. Process Workflow.

On the iOS application end, user events are stored in Firestore. When the visualizations are accessed, the app calls the serverless function API, which then starts processing the required data and generates the relevant graph. Within the functions which are written in Python, the data is accessed from the Firestore database and stored as a Pandas Dataframe. This data frame is then subjected to various data processing techniques to prepare the data for further analysis. This includes cleaning and formatting of the data before new values are calculated using the existing data such as the average response times and average force values. After this point, the prepared data is processed and plotted against different progress-tracking models by taking the number of trials, total duration, response time, and force values into consideration. The plotting of the charts is handled using Plotly. The serverless function then responds to the iOS application with a graph with is rendered on the app.

IV. Results: Visualization & Interpretation

This section showcases the results that were achieved from the data analysis and how they can be interpreted to visualize progress tracking.

A. Insights for Company

The data sent to the analytics platform can be used for various business intelligence scenarios such as calculating Active Users, User retention, activity usage analysis and so on.

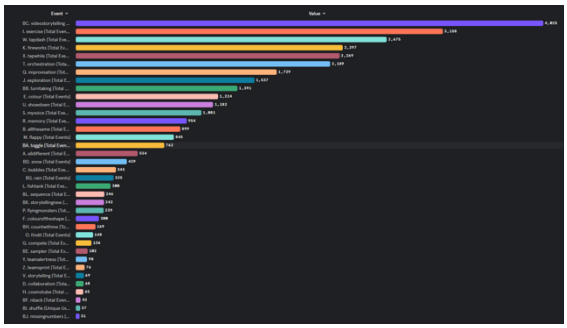

Figure 4. Comparison of metrics of different activities.

B. Interpretation for Progress Tracking

When the user selects any previous experiment/ session they are presented with the graph in Figure 5, which shows them the time it took for them to complete each individual trial in each session. Since the configurations of the session remain consistent any change in time can be assumed to be because of the patient. Here, lower times denote better performance and vice versa. The variance in times can be an indicative metric of the patient's progress. This chart is independent of all other sessions (except for the average trial time) meaning that this can be used for immediate feedback of the patients.

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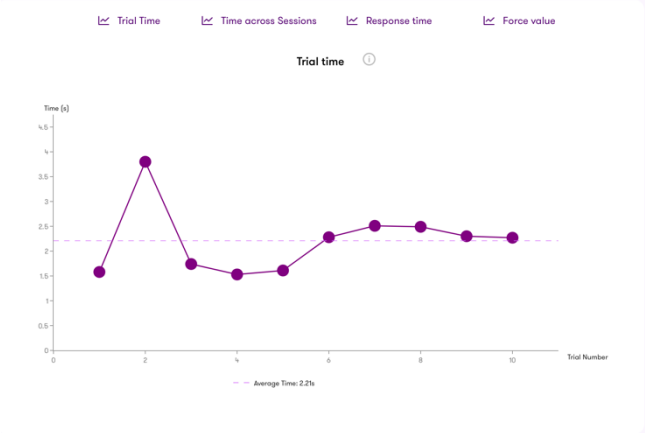

Figure 5. Trial Time.

In Figure 6, the graph represents the average time for a patient to complete a trial over multiple sessions. This can be an overall indicator of progress since the time taken is plotted against the date the session it was conducted on. Therefore, it can be used for tracking whether there has been progress over a certain duration of time. This can be useful in a therapy setting or for students who play the sessions in schools where sessions are conducted weekly provided the same configurations are replicated for each session.

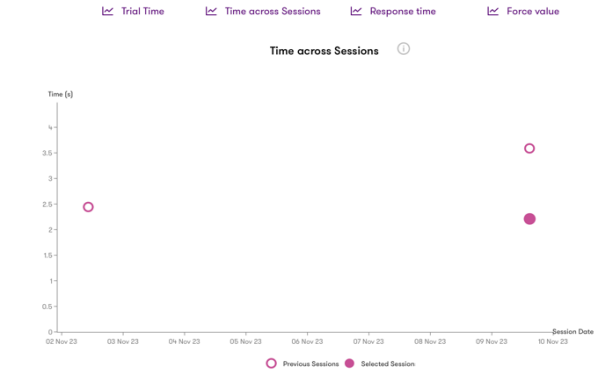

Figure 6. Time Across Sessions.

Another measure of progress that can be calculated is by using the key metric - response time. The response time denotes the time taken to press a specific cosmoid after it was lit up. For the experiment, the cosmoids are always lit up in a specific color palette making it easier to track response time over multiple sessions. These response times are all tracked for each session and a final average response time for the entire session is calculated alongside the average response time of all other sessions with the same configuration. The average of all sessions is then plotted against the average of a specific session to see the difference in response times for each cosmoid collected.

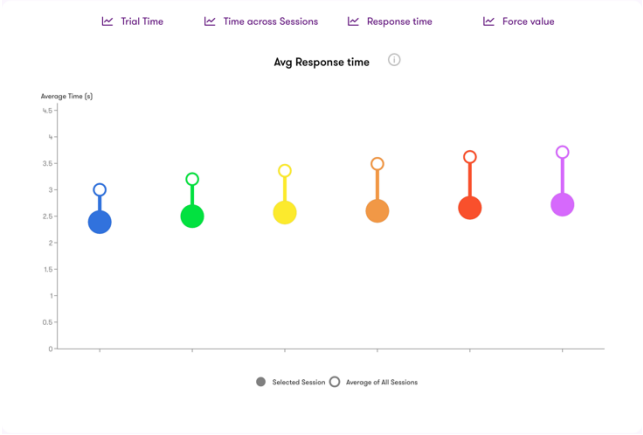

Figure 7. Response Time.

In Figure 7, we see two distinct types of plots can be seen paired up by color. For example, a larger dot (Selected session average response) and a smaller dot with just an outline (average of all similar sessions) of the same color are plotted and joined by a line of the same color. Here, we see a comparison between the average response time of one specific session versus the overall average of similar sessions. If the average response time of the selected session is lower than the average response time of the overall sessions it can be interpreted as positive progress in that session.

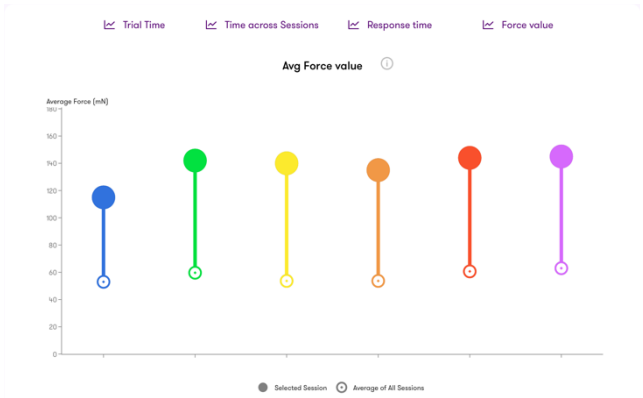

Figure 8. Force Values.

Similarly, the final measure of progress is calculated using force value. The force value denotes the force with which a specific cosmoid is pressed after it was lit up. The calculations are performed in the same way for force values where the average of the session and the average of all sessions are calculated and compared. This can be seen again in Figure 8, where two distinct types of plots can be seen paired up by color. The larger dot (Selected session average force value) and a smaller circle with an outline and dot in the middle (average of all similar sessions) of the same color are plotted and joined by a line of the same color.

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Here, we see a comparison between the average force value of one specific session versus the overall average of similar sessions. Positive progress for force value can be interpreted if the value of the larger dot is less than that of the smaller circle denoting that the cosmoids have been pressed harder.

V. Conclusion and Future Work

This paper presents the research that was carried out to highlight the potential of assistive technologies and how a data-driven approach can be leveraged for critical decision-making processes while at the same time also providing useful insights to the users. To explore this potential, research was done on previous case studies related to assistive technologies and how the data they generate are being used. To add to that, a personal experiment was conducted alongside Filisia Interfaces Ltd with their assistive technology implemented in an EdTech setting. Data was collected from therapy sessions/ learning environments where the relevant metrics (response time, force value, and trial duration) were built into the activities to facilitate progress tracking for the users. These metrics were processed and analyzed and rendered as graphs. The visualizations provide a means of progress tracking for the therapists and schoolteachers for a particular user by interpreting the metrics of a particular session individually or with all conducted sessions to gauge physical or cognitive progress depending on the user's condition. To summarize, the experiment focused on the viability of the data collected from their device for critical internal decision-making and at the same time provide a means of progress tracking to their users in a therapy/ school environment.

To add to this, from a technological perspective, this same model can also be used in conjunction with different ML models for adaptive gaming where the data will be processed to predict and adjust the difficulty and/or configurations of a user based on how they are performing in them. From a research perspective in SEND, this approach can be utilized to discern if there are any specific markers in the data for certain physical or cognitive conditions that can be recognized and potentially be used for predicting said conditions which is one way to address the gap in terms of research and development.

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Comparing CEM and CRM: A Literature Review

Marie-Noëlle Forget
Dept. of Analytics, Operations and IT
ESG UQAM
Montreal, Canada
email: forget.marie-noelle@uqam.ca

Pierre Hadaya
Dept. of Analytics, Operations and IT
ESG UQAM
Montreal, Canada
email: hadaya.pierre@uqam.ca

***Abstract*—Despite the increasing interest given to Customer Experience Management (CEM) in both the literature and organizations, there is still confusion surrounding the concept. Moreover, CEM is often confused with Customer Relationship Management (CRM) and the relationship between both is unclear. Given the recent rise in CEM software on the market, as well as the already well-established CRM software available, it is important to understand what the differences are, if any, between CEM and CRM to guide the future development of software packages. This paper reviews the literature on both CEM and CRM and analyzes definitions of both concepts to identify if there are major similarities and differences between them. We find that while they are different, they do share important similarities. It would thus be more convenient and efficient to develop CEM software in collaboration with CRM software.**

Keywords-customer experience management; customer relationship management; literature review.

I. INTRODUCTION

In today's fast-changing environment, organizations must multiply their efforts to gain and, more importantly, sustain a competitive advantage. To that end, Customer Experience Management (CEM) is increasingly adopted. Indeed, some believe that customer experience is nowadays what allows organizations to differentiate themselves from their competitors [1].

Despite the growing enthusiasm surrounding CEM, confusion on the topic remains in the literature. First, the concept at the heart of CEM, i.e., "customer experience", remains unclear. Indeed, the concept is defined in multiple ways in the literature. While some authors speak of a subjective response from the customer to an organization [2], others speak more of a sum of interactions with the customer [3]. Second, researchers and practitioners do not agree on what CEM is and often confuse it with customer relationship management (CRM). Indeed, the relationship between CEM and CRM is still unclear [4]. While CEM is at times considered to be part of CRM [5], the opposite is rather suggested at other times [6]. With all this confusion, it is still not possible to determine what really differentiates the two concepts. Are they really different, or is CEM simply an upgraded version of CRM? If they are different, do they intersect, and if so, in what capacity?

Very little research has been conducted to clarify the relation between both concepts. To that end, Homburg, et al. [7] have made, to our knowledge, the most important contribution to date. They propose four dimensions in which CEM and CRM differ, i.e., cultural mindsets, strategic directions, firm capabilities, and primary goals. While they propose a valuable starting point, more work must be done to clearly identify all similarities and differences between both concepts. Indeed, recent studies on CEM recognize that CEM has still not been sufficiently differentiated from CRM [4].

The confusion surrounding CEM and CRM is exacerbated when looking at the CEM software solutions that have recently begun appearing on the market. Indeed, CEM software solutions mostly allow for the collection and analysis of customers' feedback. These functionalities could be helpful for part of CEM, as well as part of CRM. In fact, the differences between CEM and CRM software solutions that are currently on the market are not easy to identify, as both types of solutions seem to provide a very similar set of functionalities, leaving us wondering what the added value of acquiring a CEM tool is for a firm that already uses a CRM tool. Of course, CEM software is only at its early stages and will develop further in years to come. However, to develop CEM software efficiently and effectively, it is essential to understand the relationship between CEM and CRM. Indeed, if both concepts are different and do not intersect, it makes sense to develop standalone CEM software solutions. However, if one concept is the extension of the other, then it would be more efficient to build on existing CRM software. Understanding their relationship would also allow for better integration between both software solutions.

Therefore, the objective of this paper is to determine, by analyzing definitions of CEM and CRM, whether the two concepts are distinct and to identify what are the main distinctions between them, if any. In the next sections, we present the methodology, we discuss our results and, lastly, we conclude with future research avenues.

II. METHODOLOGY

To reach our research objective, we conducted a literature review on both CEM and CRM. The steps of the review process are presented in Figure 1.

The first step consisted of searching the literature to find relevant studies. We used the database ABI/INFORM and searched the four following expressions: "customer experience management", "CEM", "customer relationship management", and "CRM". To ensure that we could find as many relevant studies as possible while limiting the scope of

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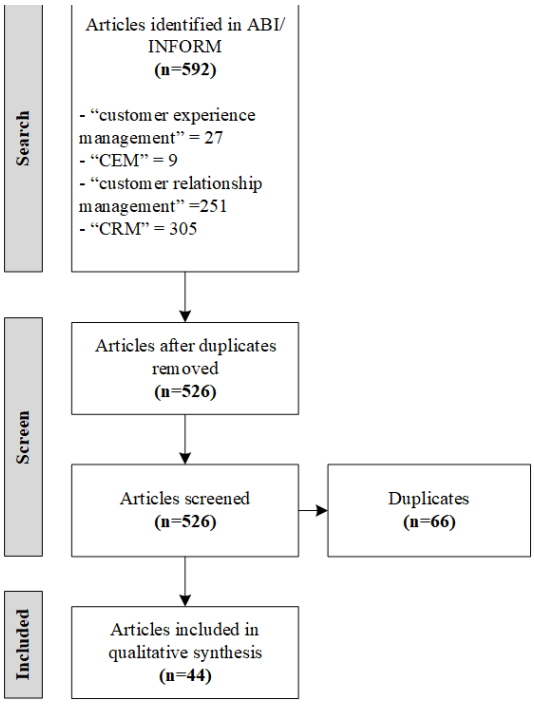

Figure 1. PRISMA flow diagram of the review process.

the search, we searched only in the title. We also limited our search to peer-reviewed academic papers written in English. We found 526 studies as the result of the first step.

The second step was the screening of the 526 identified studies. Since we wanted to identify definitions and that a definition could be found in any section of the studies, we read in full all studies identified in the previous step, paying special attention to sections such as the introduction, the background/review of the literature, and the results.

In the third step, we extracted all definitions of customer experience, CEM, customer relationship, and CRM. As a result of this step, we found 18 definitions of customer experience, 19 definitions of CEM, and 34 definitions of CRM. No definitions of customer relationship were found.

Lastly, we conducted a qualitative analysis, which was subdivided into three steps that are presented in the next section.

III. RESULTS

Having now extracted all the definitions found in the literature, our qualitative analysis was divided into three steps that are each presented in the following paragraphs. First, we analyzed the definitions related to CEM. Second, we analyzed the definitions related to CRM. Third, we compared the elements that stood out from our analysis to highlight the similarities and differences between CEM and CRM.

A. *Customer experience management*

We found 19 definitions of CEM, as well as 18 definitions of the concept at the heart of CEM, i.e., customer experience. Because of paper size constraints, we only present a subset of the definitions of customer experience found in Table I. Those definitions, together, illustrate the elements that stood out during our analysis. The same applies to the definitions of CEM and CRM, presented in Table II and Table III respectively. Please contact the authors for the list of all definitions and references included in the analysis.

The first noticeable element in the definitions of customer experience is that the emotional and sensorial aspect is put forward in most definitions. Second, customer experience encompasses the whole customer journey that includes all touchpoints between an organization and the customer. Third, not only are direct interactions influencing the customer experience, but indirect interactions, such as word-of-mouth or online reviews, also influence the customer experience. Fourth, considering the definitions as well as the three previous elements, the customer experience is highly subjective. Indeed, the same interaction could generate different emotions for different customers.

TABLE I. DEFINITIONS OF CUSTOMER EXPERIENCE

Customer experience definitions	References
[…] holistic in nature involving the customer's cognitive, affective, emotional, social and physical responses to any direct or indirect contact with the service provider, brand or product across multiple touchpoints during the entire customer journey.	[8]
[…] the evolvement of a person's sensorial, affective, cognitive, relational, and behavioral responses to a firm or brand by living through a journey of touchpoints along prepurchase, purchase, and postpurchase situations and continually judging this journey against response thresholds of co-occurring experiences in a person's related environment.	[9]
[…] internal feelings of customers when facing various interactions with firms, whether direct (e.g. usage, service consumption and purchase) or indirect (e.g. online reviews, word-of-mouth and advertising)	[10]
The customer's sensorial, emotional, cognitive, behavioral and social responses to a firm's offerings during the customer's entire purchase journey.	[4]
[…] a multidimensional concept focusing on customer's cognitive, emotional, behavioral, sensorial, and social response to a business offering and performance.	[11]
[…] events that engage individuals in a personal way.	[12][13]
[…] a customer's subjective responses that are the result of interacting with an organization. It covers all interactions, e.g. purchasing, searching, consuming and seeking product or service support.	[14]
[…] a set of interactions between a customer and a product, a company or a part of its organization, which provokes a reaction.	[12][15]
[…] the internal and subjective response customers have to any direct or indirect contact with a company. Direct contact generally occurs in the course of purchase, use, and service and is usually initiated by the customer. Indirect contact most often involves unplanned encounters with representatives of a company's product, service or brands and takes the form of word-of mouth recommendations or criticisms, advertising, news reports, reviews and so forth.	[15][16]
[…] the cognitive and affective outcome of the customer's exposure to, or interaction with, a company's people, processes, technologies, products, services and other outputs.	[17]
[…] the internal feelings of customers when facing various interactions with firms, whether direct (e.g. usage, service consumption and purchase) or indirect (e.g. online reviews, word-of-mouth and advertising).	[18]

Now that we have a good understanding of what is a customer experience, we analyzed the definitions of CEM. A sample of the definitions found in the literature is presented in Table II.

First, we noticed that a lot of emphasis is put on customer experience. Indeed, many define CEM simply as the management of customer experience, without delving into what the "management" entails. The activities required in CEM are mostly overlooked. Second, there is no consensus regarding what CEM entails, as it is defined as a cultural mindset, a strategy, a process, a discipline, a methodology, and/or capabilities. Third, the goals of CEM include sustaining a competitive advantage and customer loyalty.

B. Customer relationship management

While we found many definitions of customer experience in the literature– in fact almost as many as for CEM– we did not find a single definition of customer relationship. Indeed, in the CRM literature, there is not much emphasis on the customer relationship. The emphasis is rather on the actions that an organization must undertake to manage this relationship.

TABLE II. DEFINITIONS OF CEM

CEM definitions	References
[…] the management of the customer-firm relationship along the customer journey, from need generation to post–purchase	[19]
[…] the name given to the 'Total Customer Experience' strategic management process in a firm, which involves the firm's efforts to improve the quality of interactions with consumers in consistent and effective encounters.	[20]
[…] the cultural mindsets toward CEs, strategic directions for designing CEs, and firm capabilities for continually renewing CEs, with the goals of achieving and sustaining long-term customer loyalty.	[9]
[…] the process of strategically managing a customers entire experience with a product or company. It represents the discipline, methodology and/or process used to comprehensively manage a customer's cross-channel exposure, interaction and transaction with a company, product or service.	[11][12][13][21]
[…] the evaluation of important experience of the customers satisfaction with organizations.	[22]
[…] a strategy for retailers to design customer experience in a way that creates value both to the customer and the firm. […] a strategic approach including continuous processes of competitive advantage creation through blending rational and emotional experiences and effective management of touchpoint cycle.	[12]
[…] the discipline of managing and treating customer relationships as assets. The goal is to transform your satisfied customers into loyal customers and loyal customers into advocates of your brand.	[15]
[…] the managing of customer's perception and their rational, physical, emotional, subconscious and psychological interaction with any part of the organization.	[12][15]
[…] the discipline, methodology and/or process used to comprehensively manage a customer's cross-channel exposure, interaction and transaction with a company, product, brand or service.	[16]

When examining the definitions of CRM that were found, several elements stand out. First, while the literature on CRM is far more developed than the literature on CEM, the concept of CRM is still not clearly defined. Indeed, it is defined in a variety of ways, such as a culture, a set of practices, a strategy, and even processes. Second, while this was not the case with CEM, CRM at times refers directly to the technological tool that supports the management of customer relationships. As a matter of fact, some authors point out that distinction [23]. Third, understanding customers and improving interactions with them is at the heart of CRM. Fourth, CRM has many objectives, such as increasing customer satisfaction, customer loyalty, and profit.

C. Comparison of CEM and CRM

Now that we have a better understanding of both CEM and CRM, we were able to compare both concepts to identify the similarities and differences between them. We found four main similarities. First, the customer is central to both CEM and CRM. Indeed, both are focused on understanding the customer and improving their interactions in one way or another. Second, both CEM and CRM are iterative. Whether we want to manage the customer experience or customer relationship, we must do so in an ongoing manner. Third, they both have similar goals, such as customer satisfaction and loyalty. Finally, some definitions of CEM relate to CRM and vice versa. For instance, Das and Hassan [24] define CRM as: "the full set of activities managed through administering the customer engagement, establishing long-term business relationships and enhancing customer experience [...]". Thus, according to this definition, the activities that enhance customer experience would constitute a part of CRM. Other examples include CEM being defined as "the management of the customer-firm relationship along the customer journey [...]" [19] or as "the discipline of managing and treating customer relationships as assets" [15].

TABLE III. DEFINITIONS OF CRM

CRM definitions	References
[…] a business strategy designed to help organizations understand and anticipate the needs of its potential and present customers.	[25]
[…] as the combination of technology and business process which seeks to understand a firm's customers in the angle of who, what they are like and what they do.	[26]
[…] a modern and developed tool for data mining of customer's data which is supported by using of various communication points in system and create comprehensive point of view from customers.	[23]
[…] the process of formulating and implementing marketing activities that are characterized by an offer from the firm to contribute a specified amount to a designated cause when customers engage in revenue-providing exchanges that satisfy organizational and individual objectives.	[27]
[…] building a customer-oriented culture by which a strategy is created for acquiring, enhancing profitability and retaining customers. that is enabled by an IT application; for achieving mutual benefits for both the organization and the customers.	[28][29]
[…] the full set of activities managed through administering the customer engagement, establishing	[24]

long-term business relationships and enhancing customer experience, which is maintained through client service and connections with consumers.	
[…] a comprehensive strategy and process that enables an organization to find, acquire, retain, and nurture profitable customers by creating and maintaining long-term relationships with them.	[30]
[The] strategic use of information, processes, technology, and people to manage the customer's relationship with your company (Marketing, Sales, Services, and Support) across the whole customer life cycle.	[31]
[…] an enterprise approach to understanding and influencing customer behaviour through meaningful communication in order to improve customer acquisition, customer retention, customer loyalty and customer profitability.	[31][32]
[…] a strategy focusing on the development of a sustainable relationship with customers, through customer data management, resulting in the acquisition, retention and increase of customers, while enhancing customer satisfaction in an ongoing manner.	[33]
[…] a core business strategy, which integrates internal processes and functions, and external networks, to create and deliver relevant value to targeted stakeholders, i.e. to ensure service excellence which results in increased student retention, loyalty, and satisfaction.	[34]
[…] a business strategy that improves an organization's competitive advantage. It is the process of relationship building between a company and its customers that enhances lifetime value and increases profitability.	[35]
[…] a tool that centralizes a customer or client information -data- and its interactions with a firm, in order to provide better services, improve operations, retention, loyalty and convert leads into sales.	[36]
[…] identifying a company's best customers and maximizing the value from them by satisfying and retaining them.	[37]
[…] a culture of business conduct of a company involving the integration of human activity, processes, and technologies —all with the aim of establishing a symbiosis of company requirements with those of user requirements, i.e. company profitability merged with customer satisfaction.	[38]
[…] a complex set of interactive processes that aims to achieve an optimum balance between corporate investments and the fulfilling of customer needs in order to generate maximum profit.	[39][40]
[…] the alignment of business strategies, organizational structure and business culture, based on customer information and information technology, in order that all contacts with clients meet their needs and achieve business benefit or profit.	[41]
[…] the processes that enable firms to manage effectively a portfolio of profitable and sustainable relationships with key customers in order to maximizing value for both shareholders and customers.	[42]
[…] an integrated information system which is used to plan, schedule and control activities before and after sales in the organization and with the goal of making customers capable of interacting with the organization through various tools such as website, phone, social media, etc.	[43]
[…] a philosophy, a comprehensive strategy which describes the process of acquiring, retaining and partnering with selective consumers to create superior value for both the business and the consumer.	[44]
[…] a customer-focused business strategy that dynamically integrates sales, marketing, and customer care service in order to create and add value for the company and its customers through increased satisfaction and loyalty.	[45]

Nonetheless, we also did find important differences between CEM and CRM. First, the emphasis on emotions that are prevalent in CEM is not present in CRM. Second, while CRM focuses solely on direct interactions between an organization and its customers, CEM is also interested in indirect interactions (e.g., social media), as well as in interactions between the customers and the organization's competitors. Third, while a portion of the CRM literature is interested in CRM software specifically, this is not the case with CEM. However, we could argue that this is simply because the development of CEM software only started very recently. Fourth, CEM's focus is on the customer experience, while CRM's focus is rather on the activities required to manage the customer relationship. Indeed, the definitions of customer experience are very detailed and some authors, when defining CEM, simply add "the management of…" to what could be considered a definition of customer experience. In contrast, we found no definition of customer relationship. Finally, the main difference concerns the scope of CEM and CRM. For the former, the unit of analysis is the whole customer journey, while for the latter, the unit of analysis is the interaction between the organization and the customer, which accumulates over time, building a relationship.

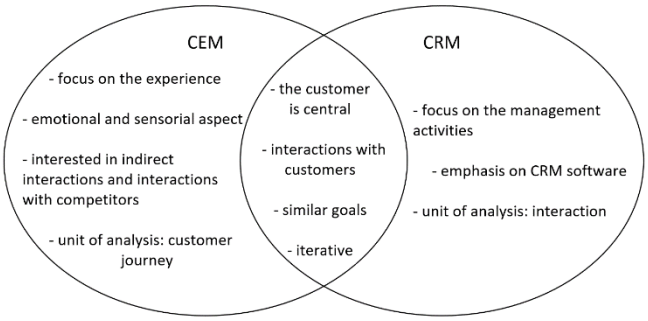

Figure 2. CEM vs CRM.

We summarized the similarities and differences in Figure 2. Following our analysis, we can acknowledge that CEM and CRM are indeed different. However, as illustrated in Figure 2, both concepts intersect with one another. Considering that CEM and CRM share important similarities, we believe that both concepts and, ultimately, software supporting both CEM and CRM, are complementary. Therefore, it would be preferable to develop CEM software in collaboration with CRM software, rather than in silos as it seems to be currently the case in the industry. For instance, we found that the interactions with the customers are central to both concepts. CRM software tools already propose powerful functionalities to keep track of all the interactions that an organization has with each of its customers. CEM software tools can therefore benefit from these already existing functionalities. Building on CRM software functionalities is also helpful in avoiding the duplication of relevant information in CEM tools and CRM tools. CEM software development efforts should therefore be focused on elements that distinguish CEM from CRM. For instance, we should investigate how CEM software could best capture the emotional and sensorial dimensions of customers' interactions.

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IV. CONCLUSION

We conducted a literature review to determine whether CEM and CRM are really distinct concepts and to identify the main similarities and/or differences between them. We found 18 definitions of customer experience, 19 definitions of CEM, and 34 definitions of CRM. We conducted a qualitative analysis to highlight the main similarities and differences between CEM and CRM. Our analysis showed that CEM and CRM are indeed different, the main difference being their unit of analysis. Even though they are different, we also found significant similarities that should be taken into account in the development of CEM software. Indeed, the development of emergent CEM software could benefit from building on existing CRM software, which is already mature, rather than trying to build new software from scratch. Moreover, CRM and CEM software should be closely integrated, as they both share some activities.

This literature review revealed two promising research avenues. First, further research should be conducted to specify the differences between CEM and CRM, especially from a process standpoint. Indeed, knowing what activities they both have in common could be especially useful for the development of CEM software as well as for the integration of new CEM software with existing CRM software. Second, we identified a gap in the literature regarding CEM software specifically. Indeed, while we found a considerable number of academic studies on the topic of CRM software, we did not find studies on CEM software. Future research should take an interest in the topic, both in analyzing the new CEM software coming on the market, and in exploring how best to go about developing such software.

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