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An Explanation of the Codebook for Analysing Extended Reality Development

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Abstract
The Covid-19 pandemic highlighted the importance of virtual systems during physical isolation. Extended Reality (XR) is an alternative to disruptions of physical reality. Therefore, there is a need to increase the development of XR projects. This paper provides a reference codebook to identify critical elements for developing or assessing any XR project. The review of the paper "Analysis of Caribbean XR Survey Creates an XR Development Strategy as a Path to the Regional Metaverse Evolution" provided the codes. The analysis of the development strategy's elements identified factors that encourage XR project creation, completion, and accelerated development. The codebook consists of 24 codes, grouped into categories: strategy and policy, financial, software, human resources, training, geographic, industry sector, design, UX, and I4.0. It employs a three-step process: code familiarisation, code application, and analysis and assessment of coded information. A concise summary table facilitates easy usage. The codebook provides a systematic approach to analyse XR development from ideation to Proof of Concept. It enables stakeholders to identify core requirements, prioritise factors of influence, allocate resources, and select target markets. These codes also assist in evaluating ongoing initiatives and identifying areas for improvement or refinement. Stakeholders can use the codebook for post-mortem analyses to inform strategic actions and optimise future XR projects. This paper's value is a clearly defined set of codes influencing XR project development with a recommended usage process. Stakeholders can leverage these codes to unlock the potential of XR projects to enhance their impact, originality, and market effectiveness.

Contents

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1. Introduction

This codebook's specific design assesses the development of Extended Reality (XR) projects at various stages in their lifecycle. It also facilitates the extraction of information from literature containing XR development strategies for further analyses, such as thematic or content analysis. This valuable analytical tool consists of clearly defined thematic elements that affect the development process. These elements provide a consistent framework for multiple stakeholders involved in the XR development ecosystem to monitor and assess the progression and completion of an XR application. The codes provide a structured and systematic approach to evaluate the presence of critical components that affects the successful creation of XR projects.

The codebook becomes a valuable resource to encourage and accelerate the advancement of any type of XR project across multiple industry sectors, enhancing innovation, competitiveness, and sustainability within a geographic region (Rameshwar and King, 2020, 2022). These types of virtual projects can reduce the effects of disruptions to physical systems during isolation activities such as events during the Covid-19 pandemic (Rameshwar and King, 2023). Therefore, there is a need for an alternative to the physical reality.

XR (extended reality) is the term for the group of realities created in the virtual domain. These are identified as virtual reality (VR), augmented reality (AR), and mixed reality (MR) (Matthews et al., 2021; Rauschnabel et al., 2022; Vasarainen et al., 2021). The distinction between VR, AR, and MR focuses on the interactions between the different realities (Rameshwar and King, 2023). VR replaces the signals from the real (physical) world with artificially created (computer-generated) stimuli. These altered virtual versions trigger the users' senses and they experience a new reality. AR adds information to the real world. It augments the stimuli to provide an enhanced perception of the physical world. MR encompasses the best of VR and AR that gives the user a choice between full immersion in an artificial world, with the former, and enhancing the natural environment through manipulated data, via the latter.

This paper comprises the following sections. The methodology is the second section. It briefly outlines the approach used to develop the codes from the reference document. The third section specifies the codes and provides explanations for their selections. The conclusion is the final section. It is a summary of the codebook and a recommendation on its use.

The main objective of this study is to develop a comprehensive codebook for analysing XR development. The outcomes of this codebook are to assess the development of XR projects at various stages in their lifecycle and to facilitate the extraction of information from literature containing XR development strategies for further analyses. A key aspect of achieving these outcomes is the creation of a codebook consisting of clearly defined thematic elements that affect the development process, providing a consistent framework for multiple stakeholders involved in the XR development ecosystem to monitor and assess the progression and completion of an XR application. The main contributions of this article are:

1. The development of a comprehensive codebook for analysing XR project development
2. The provision of a structured and systematic approach to evaluating the presence of critical components that affect the successful creation of XR projects
3. The identified factors of encouragement and acceleration to advance XR project development across multiple industry sectors, thus enhancing innovation, competitiveness, and sustainability within a geographic region
4. The establishment of a three-step process for applying the codebook, including code familiarisation, code application, and analysis and assessment
5. The promotion of a proactive approach to XR project development using the codebook and its specific codes to identify the essential elements of an XR application, prioritise focus areas, and ensure the consideration of necessary resources and target markets before starting the project
6. The facilitation of work-in-process (WIP) analysis using the codebook to evaluate ongoing initiatives, identify areas for improvement or refinement, and make informed decisions to optimise future XR developments
7. The provision of the codebook as a tool for post-mortem analysis to identify areas for future improvements

2. Literature Review

The use of codes and codebooks facilitates the digestion of data into understandable components to perform analysis to create new insights (Hai-Jew, 2017). The identification of the codes can arise from pre-existing information that is independent of the target data (deductive approach), the development of codes through the researcher's interaction with the data (inductive approach), or using a combination of the two (hybrid approach) (Skjott Linneberg and Korsgaard, 2019). The authors identify two key types of codes as descriptive and attributes that occur in the first cycle of coding. The former applies to using a nomenclature to represent the face value of a defined segment of data. The latter applies to inferring the meaning of the same data. Thus, in interview data about privately owned transportation systems, a descriptive code can use the word 'car' to represent the information describing a specific mode of transportation, such as a motor vehicle. However, the use of the attribute code 'convenience' represents the meaning of the information describing the benefits of using a privately owned vehicle that encompass freedom of movement, comfortable interior, privacy, and the ability to store personal items.

The second cycle of coding involves "eclectic, pattern coding, categorisation, and exploring patterns across codes" (Skjott Linneberg and Korsgaard, 2019). As such, this facilitates researchers using codes to assist in qualitative thematic or content analyses (Thomas and Harden, 2008; Vaismoradi et al., 2013) . This demonstrates the importance of ensuring that both the descriptive and attribute codes correctly frame the dataset. It also emphasises the need for an iterative process of coding data (DeCuir-Gunby et al., 2011). Hence, the recommended start is to use the process of open coding to create the initial descriptive and attribute codes followed by the process of axial coding to find or form connections (DeCuir-Gunby et al., 2011; Khaerati, 2016). The second coding process can occur in both the first and second cycles.

The relationship between codes represents the relationship between segments of data. Thus, nested data will create a hierarchical structure in which codes appear as branches of a tree connected based on the identified relationships. Otherwise, the structure of the codes is in a flat arrangement. For example, the data can inherently contain a nested structure and facilitate axial coding. Therefore, using the previous example of the 'car' and 'convenience' the former code exists under the larger grouping of privately owned transportation systems that includes motorcycles and sport utility vehicles. Fig. 1 illustrates a simple flat structure between a car, a motorcycle, and a sport utility vehicle as well as the hierarchical structure as they are all a subgroup of the privately owned transportation system.

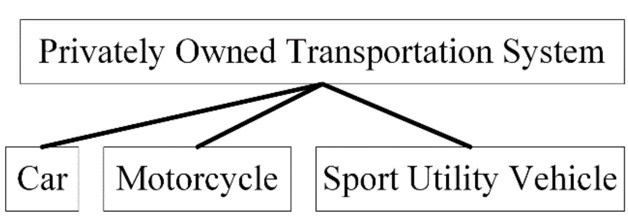

Figure 1. Example of a Flat and Hierarchical Coding Structure

Codes provide an easy-to-use format to summarise complex data. They can take the form of alphanumeric combinations of various lengths (Table 1) or use geometric shapes or colours to code information as timelines, texts, and events (Swift, 2017) or in the form of QR (Quick Response) codes (Nassereddine, 2019; Tiwari, 2016).

Table 1 illustrates examples of the types of codes researchers adopt within the research areas of healthcare, education, and technology. It demonstrates there is no strict format for coding data. Thus, they exist as phrases, single words, number or letter-number combinations with phrases or single words, and letter-only abbreviations. It shows that researchers use different forms conveniently within their work and the importance of a codebook reference to clarify the meanings of the codes. A commonality amongst many of these studies is the application of coding interview data (DeCuir-Gunby et al., 2011). Thus, there is no limit or restriction to the type of data to code.

The following two approaches used in the coding process involve achieving a measure of the reliability of the coded information:

- Conducting multiple iterations of the process to achieve saturation (Dinh et al., 2023; Faber et al., 2022; Hegde et al., 2023; Hirzle et al., 2023; Impedovo et al., 2013; Turakhia et al., 2023)
- Utilising multiple persons in the process of developing and/or evaluating codes (Çolakoğlu et al., 2023; Dinh et al., 2023; Faber et al., 2022; Hegde et al., 2023; Hirzle et al., 2023; Impedovo et al., 2013; Rajaram et al., 2023; Turakhia et al., 2023)

A review of 76 papers published between 2019 and 2023 identified in a PRISMA study on XR development strategies and policies did not reveal any codes for developing an XR project. Within these data, the researchers developed codes for the recordings of participants' responses (Williams, 2020), literature on AR use cases, benefits, or obstacles (Nassereddine, 2019), and interview transcripts (Karre et al., 2019). This finding does not prove the non-existence of specific codes for an XR development strategy given the scope of the PRISMA study. However, it demonstrates value in developing a codebook focused on an existing agnostic XR development strategy.

3. Materials and Methods

To begin with, the first step in this process was to become familiar with the secondary source data used to create the codes. This information is: The XR development strategy from the paper titled "Analysis of Caribbean XR Survey Creates an XR Development Strategy as a Path to the Regional Metaverse Evolution" (Rameshwar and King, 2023). The researcher developed the reference paper and had an inherent familiarity with the original dataset and analysis. This in-depth knowledge and experience provided greater insights into the content of the XR development strategy paper to identify suitable codes.

Table 1. Examples of Codes and their Formats used in different Research Areas

Cited Authors	Example Code(s) Used	Code Format(s)	Research Area
(Dinh et al., 2023)	1.2 Convenient access to data	Number-only with phrase	Healthcare
(Faber et al., 2022)	Challenges in Research; Confidence; EMK	Phrase; single word; Letter-only abbreviation	Education
(Hirzle et al., 2023)	C3 Contribution or main findings; C1 Category	Letter-number with Phrase; Letter-number with a single word	Technology
(Karre et al., 2019)	Lack of efficient methods/tools	Phrase	Technology
(Rajaram et al., 2023)	Granularity of sharing; Transparency	Phrase; Single word	Technology
(Houghton et al., 2017)	Social and psychological; Valuing	Phrase; Single word	Healthcare
(Impedovo et al., 2013)	Participation	Single word	Education
(Turakhia et al., 2023)	Competencies	Single word	Education
(Hegde et al., 2023)	Availability and utilisation of resources	Phrase	Healthcare
(Nassereddine, 2019)	PreCon7	Letter-number	Technology

The researcher performed an iterative process involving the continuous addition, removal, and modification of specific codes. It required an understanding of the reason for the code as well as the criteria to assess existing information to include or exclude a potential code. The intent was to produce a set of codes that are easy to understand, easy to implement, and satisfy the core requirement of analysing XR development. The following section "XR Development Codes" outlines the details of each thematic code.

A recurrent theme in the reference paper was the "need to encourage and accelerate XR development" (Rameshwar and King, 2023). Thus, the researcher identified codes that provide the ability to increase the number of persons developing XR projects, increase the number of projects that a person or group can develop, and reduce the time taken to complete a working proof of concept (PoC) application. These focused on funding, software, human resources, and training and development. The other recurrent themes highlighted the importance of Industry 4.0, design foci, UX, financial strategy, industry sector and geography within the scope of XR development. The researcher tested the final set of codes against the reference paper to determine their simplicity and effectiveness in analysing an XR development strategy.

4. Findings and Discussion

4.1 XR development codes

The open coding process developed descriptive codes from the XR development strategy (summarised in Fig. 2). It identified codes as strategy, design foci, industry sector, financial strategy, UX strategy and Industry 4.0 strategy. The selection of these codes occurs due to their clear presence in the diagram that demonstrates the importance to the overall development of XR projects. The inclusion of the policy code occurred because it is essential in decision-making. Section 4.2 clarifies this point. The design focus element contains three subgroups user, purpose, and location. Axial coding links each of these to the design focus. Therefore, the design foci code becomes three separate codes design focus user, design focus purpose, and design focus location. Section 4.9 explains the selection of each code. Axial coding also creates a hierarchical relationship between the Industry 4.0 strategy, UX strategy, and financial strategy. Section 4.3, Section 4.10 and Section 4.11 clarify the development of these codes.

The researcher based the selection of codes from the factors of influence (Table 2) on those that are independent of each other. These codes are financial, training and development, human resources, and software. The term 'financial' already existed as a code. Thus, using the word 'funding' prevents duplication and accurately reflects the code's description. The rationale for the exclusion of the other factors of influence is as follows. Development time is dependent on the previously selected codes human resources, software and financial. The four themes (learning, social engagement, physical movement, and adaptability) depend upon the first set of codes identified from the diagram as the design foci user and purpose.

The inclusion of geography as a code is because it can modify the value of other codes such as financial, training and development, human resources, and industry sector. It is also independent. Additionally, there is a relationship between geography and location as the latter is "a virtual representation of any imagined space and the users' physical positions" (Rameshwar and King, 2023). Thus, geography is only physical and location is both virtual and physical. Hence, although they are independent of each other they can represent the same information.

The researcher adopted a mixed-format code system to incorporate a variety of codes with letter-only or letter-number combinations. This approach provides the researcher and the reader with a short code version that is easy to remember and easy to use. Additionally, the format followed the variety illustrated in Table 1 as there is no standard adopted by the cited authors. This process simplified the identification, labelling, and retrieval of coded information. As an example, the presence of a clearly identified strategy will translate to 'strategy yes' which becomes the code STYE. It uses a four-letter code comprising the first two letters of each of the two key terms. The codes that focus on encouraging development use the prefix 'EN' and those that focus on accelerating development use the term 'AC'. EN codes identify information that can increase the number or types of people completing projects or increase the number of projects developed by an individual creator (or group). AC codes identify information that can reduce the development time from the initial concept idea state to a working PoC. The omission of EN or AC prefixed codes indicates it does not encourage or accelerate development. Each sub-section outlines the process to create the specific codes.

This code system has several strengths. It uses clear and concise codes that represent descriptive information. The reader can easily identify the significance of the descriptive codes by relating them to the XR development strategy. The use of prefixes easily modifies an existing code without the need to create a new one. It also illustrates the relationship to other codes linked by the same prefix.

The codes focus on the XR development strategy. This is a subgroup of the ICT ecosystem (Kang and Kang, 2019; Khan et al., 2021; Rubio-Tamayo et al., 2017). As such, the codes provide limited flexibility within the boundaries of ICT development. Additionally, the codes are not rigidly dependent upon a pre-defined set of rules specific to the XR ecosystem (as in deductive codes). Thus, the codes can apply to any ICT development activity. This work does not evaluate the ability to use the codes in non-ICT development domains.

This system also has limited scalability. This codebook keeps track of codes and their definitions. However, the process is manual and the ability to generate unique codes becomes slower and more difficult based on the quantity of pre-existing codes. It requires the researcher to check for the presence of an identical code before creating a new one. This method prevented the duplication of codes within the context of this study.

However, in the event of the formation of a duplicate code, the following approaches can ensure uniqueness. The options depend upon the relationship between the codes. One code becomes a prefix for the other code. This method works once there is a hierarchical relationship between the two codes. Another option is to combine the two codes that represent related concepts. This requires the modification of previously coded data with the merged code. If there is no relationship between the codes then the use of either a prefix or suffix or both can make the duplicate code unique. The prefix or suffix must not be identical to any pre-existing codes. Thus, although the primary codes in this paper are four characters long, it is important to note that this is not a finite limit of the code length.

The codebook provides robustness to the process. It enables a user to categorise data in an accurate, reliable, and consistent manner. The following sections outline the reasons for the codes and the codebook summary contains inclusion and exclusion criteria to guide the labelling of data.

A code containing the encourage (EN) or accelerate (AC) modifier must provide answers to who, what, when, where, why, and how about encouraging or accelerating the XR project development. This provides information to assist in understanding the reasons for decisions affecting XR development. The answer to 'who' identifies the stakeholders (people or institutions) such as the target, the beneficiary, and the responsible person(s). The answer to 'what' provides details of the item's characteristics. The answer to 'when' establishes the timeline of the events, including the dates, duration, or frequency of occurrences. The answer to 'where' provides the location of the activity. The answer to 'why' determines the purpose behind the decision. The answer to 'how' outlines the specific steps involved in the task.

Project complexity is a negative factor that extends a project completion time as well as discourages persons from either attempting or completing the application (Rameshwar and King, 2023). As such, it prevents developers from attempting technically complicated parts of or types of an XR project, completing multiple projects, or the ability to meet deadlines. Therefore, it directly affects the ability to encourage and accelerate XR development. Thus, these types of codes directly affect this problem. However, as identified below by the absence of EN or AC prefixes, some codes do not directly affect the ability to encourage or accelerate. However, they are useful in identifying the components needed to develop a successful XR project.

This paper offers a detailed breakdown of the codebook's key components based on the reference strategy as summarised in Fig. 2 and Table 2. Fig. 2 presents a concise summary of the minimum required information for an ideal XR development strategy. Table 2 illustrates the factors of influence required to develop XR projects. As such, the strategy and codebook provide a structured reference of the critical elements needed for anyone with an idea of an XR application to develop a PoC. The next section outlines the strategy and policy codes.

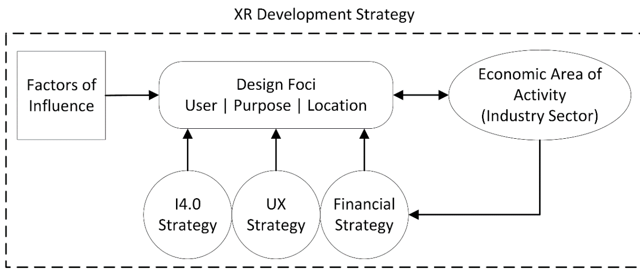

Figure 2. Summary Process Diagram of an XR Development Strategy (Rameshwar and King, 2023)

Table 2. Factors of Influence and the Minimum Criteria Required to Develop XR Projects (Rameshwar and King, 2023)

Factors of Influence	**Minimum Criteria**
Financial	Funding focused on the final phase can support project complexity and reduce completion time
Training and development	Required for projects with increased complexity
Software	Free and easy to use
Development time	Create projects faster
Human resource	Colleague or a partner to form a viable team
Learning theme	XR application should be intuitive to use and encourage innovation
Social engagement theme	XR application should be inclusive and enable human interaction for all types of users
Physical movement theme	XR application should allow the user freedom of movement
Adaptability theme	XR application should provide relevant and contextual experiences

4.2 Strategy and policy

The strategy provides the overall objective to progress from the idea to a completed PoC (Rameshwar and King, 2023). The policy addresses the decision factors (Dente, 2014; Popoola, 2016; Puentes-Markides, 2007; Swift, 2017) that answer why to identify the specifics of who, what, when, where, and how to develop the PoC. Thus, the policy extends from the strategy.

The value of the reference strategy is to improve the existing state of the XR industry within a geographic region. As such, two important strategy factors accomplish this. The first is the strategy to encourage XR development (ENST) and the second is to accelerate XR development (ACST). The policy comes next, thus similarly, it would be ENPO and ACPO. The benefit of these labels is that it identifies the existence of strategies or policies that focus on improving any type of XR development. Consequentially, a strategy (or policy) that only enables XR development does not use ENST or ACST (or ENPO or ACPO). Therefore, it only receives the labels STYE (or POYE). This indicates that a strategy to develop any type of XR project is present.

The codes STME or POME apply when there is information about the method used to develop the strategy or policy, respectively. It is important to note that simply stating the method of doing something is not a strategy or policy unless it justifies the user's decision of the action (policy) and intent or goal (strategy) because of the action. Hence, clearly stating the individual steps involved in creating an XR application that enables anyone to recreate it, does not constitute a strategy or policy.

Therefore, using the XR development strategy in the reference text as an example, it outlines the method (via the analysis of a 2021 survey of Caribbean XR developers) and reasons (such as explaining that "project complexity creates a need for a financial support mechanism" (Rameshwar and King, 2023) and that training and development are essential factors used to develop the components of the strategy). The next section outlines the financial codes involved in the process.

4.3 Financial

The financial strategy supporting XR development identifies the types of monetary mechanisms used to acquire assets to develop an XR project. The code name becomes strategy financial reflecting its hierarchical nature and thus the code is STFI. This can offset the effects of project complexity. It can be in the form of sales of various XR elements of the project in the form of NFTs or through investment funding (Rameshwar and King, 2023). The funding received can encourage (ENFU) or accelerate (ACFU) specific parts of the project.

Investments can target specific segments of geography, demographics, industry sectors, and XR project types (Rameshwar and King, 2022). For example, awarding funding to women between the ages of 13 to 18 years in Trinidad and Tobago can incentivise persons in these categories to devote time to create any type of XR application for any type of industry use. The choice of specific segments selected depends on various factors that become important in policymaking. Additionally, the number of completed projects per person (or group) is an option for another funding category. The value of the funding will influence the number of persons applying for the opportunity. Thus, it has a direct relation to an increase in the number of persons. Access to unlimited funding can remove the boundaries of the categories to allow anyone the opportunity to participate. Unfortunately, resource limitations constrain this ideal context.

The level of funding can have an associated effect in reducing the project's completion time. One way it can accomplish this is to provide daily living expenses for creators. This removes the need for substantive employment and enables them to focus only on completing the XR project. The procurement of special software, additional developers, or training and development courses can also reduce the time in specific segments of the application's development process. The following three sections outline these areas in more detail.

As such, the funding received has dual effects in encouraging and accelerating project development. Thus, the funding entity has a profound effect on encouraging and accelerating XR project development. This occurs through decisions made on the total fund's value; fund disbursement based on specific categories such as geographic, demographic, industry sector, and XR project types; timing and partial value of the fund allocation such as, before the project, milestone completion, or after the project; and allowable payments using the fund.

4.4 Software

The financial considerations outlined in the previous section have important implications for the software development process, as they can affect the resources and tools available for the project. Thus, the appropriate XR development software can reduce the complexity of the process. Thus, the choice of software can encourage (ENSO) and accelerate (ACSO) the development process. The following examples highlight this point.

Easy-to-use programs that enable the creation of virtual elements and facilitate seamless integration into the production pipeline will lower the barrier to entry and increase the number of persons attempting XR development (Rameshwar and King, 2023). It also reduces the completion time from the idea stage to the PoC stage.

The use of AI's Text-to-Image feature using prompt engineering allows a creator with limited technical programming ability to generate complex images, including 3D models (Ho et al., 2022; Liu and Chilton, 2022; Poole et al., 2022; Wiggers, 2022). It can also generate the code to then paste into the software's text editor to generate a 3D element (Niko, 2023; Polygoningenieur, 2023). Generative AI can also provide the ability to convert Text-to-XR through the creation of virtual experiences in real time (Versy FZCO, 2023)

The evolution of using text prompts with generative AI to create XR-related content reduces the value proposition of application creation as anyone becomes capable of producing a product. Thus, it underscores the importance of an XR development strategy to guide the entire process and the choices of factors influencing the strategy. However, the use of these advanced tools does not negate the value of creators.

4.5 Human resources

The project's complexity affects the selection of human resources. Matching the project's specific needs with appropriately skilled developers reduces the completion time and therefore accelerates the development (ACHR) (Rameshwar and King, 2023).

Although this factor does not directly encourage anyone to engage in the process, it can encourage an increase in the number of completed projects by a creative group (ENHR). The size of the group can influence the number of projects completed within the timeframe. However, this only works if there is an alignment between the human resource capacities and the various projects' tasks. Thus, the project must be modular to allow this decentralised approach to development. The adoption of the Industry 4.0 (I4.0) strategy assists in this process.

As noted in the previous section (Section 4.4), the use of AI can offset the need for traditionally skilled programmers in specific languages and development platforms. However, it emphasises persons' competency in prompt engineering to use AI systems. Therefore, there is a need to upskill human resource capacities to meet the evolving needs of a project and adapt to emerging technologies used to create XR projects. This highlights the importance of the next section which defines the training and development codes.

4.6 Training and development

As noted previously, the use of AI reduces the dependence on expert knowledge and experience in specific programming languages and development platforms to generate specific virtual elements. Thus, the advancement, popularity, and ease of use of AI Text-to-Anything platforms (Calmettes et al., 2023; Choudhary, 2022; Nopanen, 2022) affect the type of training and development needs. This requires an understanding of the project's complexity and the individual competencies of the group to determine the type and level of training to provide (Rameshwar and King, 2023).

The following example outlines the various methods to obtain a 3D asset, such as a car. Developers can use their existing knowledge and experience of a 3D software platform to create the asset. Novices can use the code and instructions, provided by an AI, directly in the 3D software platform. Persons unfamiliar with 3D modelling software can use AI to generate the 3D model directly or obtain an existing 3D model from a virtual asset marketplace. Each alternative requires various levels of training.

However, the process may also involve combining specific options if a particular solution does not provide the expected result in terms of usability and time. Thus, targeted training can encourage anyone to develop an XR application (ENTD) and it can accelerate the production process (ACTD). Although the training can be virtual and accessed globally, there are examples of geographic-specific programmes based on an investment entity's funding priority (Loutoo, J., 2021; OAS, 2021). The following section delves into the role of location in shaping the development of XR applications.

4.7 Geography

As noted above, geography affects the quantity and focus of investment funding and the types of training and development available in the country. Geographic information also defines potential target markets (as defined by industry sectors) for XR projects and the human resource capital of that area. Additionally, grouping countries into geographic regions provides a larger collective entity. This can benefit from economies of scale through aggregated resources, developers, and end users. As such, there is a relationship between geography and the economic areas of activity (industry sectors) (Hidalgo et al., 2018). Therefore, it is important to capture the geographic focus and industry sectors (noted in the following section) associated with XR development. It can also identify centres of excellence in XR development.

The geographic information captured specifies where XR development occurs. The code used is G followed by the M49 value (United Nations Statistics Division, 2023). This numeric value makes it difficult to identify the country without the reference table. Alternatively, the ISO 3166 alpha 3-letter code (ISO, n.d., 2023; United Nations Statistics Division, 2023) provides an easier visual reference to identify the represented country. For example, Trinidad and Tobago is TTO. Unfortunately, it does not have codes for geographic regions. However, the M49 numeric code also identifies geographic regions. Thus, Trinidad and Tobago is G780 and the Caribbean is G029. Therefore, the choice between the M49 and ISO 3166 depends upon the need to code a region.

4.8 Industry sector

Creators may develop an XR application for use within a specific industry sector, such as education or manufacturing (Rameshwar and King, 2023). The importance of classifying this focus assists in grouping projects to better allocate resources (such as funding, training, and software) and affect the financial strategy (such as targeting clients or funding).

Additionally, a particular industry sector would have specific requirements for an XR application. For instance, in education, there is the need to assess the user's understanding of the material. Thus, the application should provide assessment and feedback to evaluate the progress made in improving knowledge and skills within a lesson's objective. However, in manufacturing, the aim would be to access real-time information about manufacturing equipment (such as temperature or power) while performing a specific task.

The code to use is I, for the industry sector, followed by a three-letter symbol for the economic area using the abbreviated term in the UN ISIC (International Standard Industrial Classification) (United Nations, 2008). Alternatively, a more granular approach is the use of numeric codes that can further subdivide each core category into division, group, and class.

For example, the sector arts, entertainment, and recreation contains four divisions, with each division containing one or more groups and classes. However, the researcher decided to simplify the identification of the sectors rather than use the complex numeric approach. Table 3 illustrates an example of the codes. The first letter in each of the key terms becomes part of the industry abbreviation. In instances with only two key terms separated by 'and', the letter 'A' joins them. Thus, the code for mining and quarrying becomes IMAQ.

An XR application developed for use in multiple industry sectors will have more than one applicable code. This occurs if the developer incorporates the I4.0 strategy to enable changes to the modular components of the project. This can change the details of the user, purpose, and location design foci to suit the specific needs of various sectors. The next section specifies the codes for the design foci.

4.9 Design foci

As noted above, the design foci consist of the user, location, and purpose. It defines the specific functionality parameters of the application's content. Each focus provides a level of detail to enable a creator to customise the features of the program that will immerse the user.

The design focus user (DFUS) outlines the characteristics of the person (or a variety of persons) intended to use the XR project. These user personas (Chang et al., 2008; Pruitt and Grudin, 2003) provide depth for the storytelling framework that engages the end user. The narrative of the story is always in the first person as it represents the user's experience of human-computer interaction. It incorporates the answers to the questions of who, what, when, where, why, and how.

As such, the personas include the other design foci of purpose (or task) (DFPU) and location (DFLO). The label DFPU refers to a clearly defined identification of the tasks performed by an individual using the XR application. The label DFLO applies when the development provides a clear identification of where someone will use the XR application or the virtualised environment used within the

Table 3. Industry Codes based on the UN International Standard Industrial Classification of All Economic Activities (United Nations, 2008)

Code	Full name
IAFF	Agriculture, Forestry and Fishing
IMAQ	Mining And Quarrying
IMAN	MANufacturing
IEGS	Electricity, Gas, Steam and air conditioning supply
IWSW	Water supply; Sewerage, Waste management and remediation activities
ICON	CONstruction
ITRM	Wholesale and retail Trade; Repair of Motor vehicles and motorcycles
ITAS	Transportation And Storage
IAAF	Accommodation And Food service activities
IIAC	Information And Communication
IFAI	Financial And Insurance activities
IREA	Real Estate Activities
IPST	Professional, Scientific and Technical activities
IASS	Administrative and Support Service activities
IADS	Public Administration and Defence; compulsory Social security
IEDU	EDUcation
IHAS	Human Health And Social work activities
IAER	Arts, Entertainment and Recreation
IOSA	Other Service Activities
IHGS	Activities of Households as employers; undifferentiated Goods- and Services-producing activities of households for own use
IEOB	Activities of Extraterritorial Organizations and Bodies

XR application. Thus, DFLO refers to the user's presence within two types of reality, the physical and the virtual.

A greater and more accurate persona level of detail enables the creator to translate this information into the program to improve realism and functionality. Therefore, the application of data-driven personas (McGinn and Kotamraju, 2008) is a quantitative and qualitative tool that creates personas based on real people that can also identify outliers within the sample population.

However, issues arise when the persona used in the design is not the same as the end user. A similar problem exists when there are multiple varied end users and only one persona design. Adopting the I4.0 strategy can overcome this problem (Rameshwar and King, 2023). It facilitates customisation through the development of interchangeable user, purpose, and location foci based on a variety of personas. This creates a unique immersive experience for each user that is part of the UX strategy. The next section outlines this code.

4.10 UX strategy

As noted above, each persona identified to use the XR application would have a specific expectation of user experience (UX). The stimulation of any or all of the senses (sight, sound, smell, taste, and touch) affects the experiences. The UX benefits can be intuitive, customised, contextual, relevant, hands-free, or a combination of any of them (Rameshwar and King, 2023). Therefore, as the UX affects each design focus, it is important to have a detailed UX strategy that assists in developing the design foci to add value to the user. The label STUX applies if there is a clear identification of the experiences that users achieve. This reflects the hierarchical code name strategy user experience (UX).

Utilising the examples from the reference paper (Rameshwar and King, 2023), a tourist and engineer would require different user experiences. The tourist's preference may be to have passive viewing. This provides views of the virtualised historical building in the form of a tour guide highlighting facts that a tourist finds significant. Whereas, the engineer prefers active viewing. This provides a level of control over the presented information. Thus, the engineer can evaluate a specific portion of the building using the BIM (building information modelling) data. However, the personas may be different and the tourist may want active viewing to explore the environment without restrictions. Similarly, the engineer may only want passive viewing to focus on critical issues flagged by the BIM system.

Additionally, the viewing preference may change based on the task, such that both personas have a choice of either option. For example, this can occur if the tourist selects the passive view first to experience the curated tour guide approach and then switches to the active view to explore an area. The ability to provide this type of functionality depends on the I4.0 strategy's influence on the design foci. The next section adds clarity to the applicability of the I4.0 strategy code.

4.11 I4.0 strategy

The term Industry 4.0 or I4.0 refers to a strategy focused on the continuous evolution of connected systems based on the intelligent integration of the modular systems' value chains (King et al., 2020). As illustrated in Fig. 2, the I4.0 strategy influences the XR development process via the design foci (Rameshwar and King, 2023). This enables the development of customisable UX for a variety of personas, as noted in Section 4.9 and Section 4.10. This underscores the idea that XR is an enabling technology of I4.0 (Rameshwar and King, 2022).

Table 4 outlines a definition of each I4.0 key concept: evolution, connected systems, decentralisation, intelligent, and integration of value chains. They should influence the design foci to provide an application that satisfies the I4.0

Table 4. I4.0 Key Concepts' Definitions (Rameshwar and King, 2022)

I4.0 Key Concept	Definition
Evolution	Changes and adapts to a variety of conditions as different users, tasks and environments
Connected systems	Links the user to other virtual or physical systems that provide additional data
Decentralised	Ability to function without a permanent physical or digital link to other systems
Intelligent	The system is self-reliant and understands its purpose, and makes decisions based on data
Integration of value chains	Create new revenues and reduce costs by linking complementary activities in different departments, companies and geographies

benefits (Rameshwar and King, 2020). XR development that describes the adoption of all the I4.0 key concepts will receive the label STI4. This code represents the hierarchical code name of strategy Industry 4.0 (I4.0). However, it may not fully encompass all of the elements. Thus, partial use of the concepts will not constitute an I4.0 strategy.

The following highlights the application of the concepts to the design foci. As noted in that section, the user is either a tourist or an engineer. The task is walking through the building to view either an overlay of the cultural and historical information or data from the BIM database. The location defines the physical and virtual environments when walking through the building. These variations are possible through the application of the I4.0 strategy in which each of the key concepts adds to the ability to customise the specific user's immersive experience.

Each unique user requirement can be an issue with using different hardware platforms. However, the adoption of the OpenXR standard solves the XR application incompatibility problem caused by each user with a different hardware device (The Khronos Group Inc., 2020). This enables interoperability of the XR ecosystem.

The I4.0 strategy can also affect the ability to encourage and accelerate development. It provides the ability of multiple persons to develop parts of the project in parallel and then combine them to function as a cohesive application. Thus, it can decrease the project's completion time and increase the number of projects completed within a specific timeframe. It also enables changes to parts of the application that allows the application to evolve as requirements change. The next section focuses on this aspect.

4.11.1 Evolution

The evolution key concept of an application enables it to incorporate design changes based on varying stakeholders and their changing requirements. One example is the ability of a program designed for one industry sector (such as education) and modified for use in another (such as manufacturing). This is a change in any of the design foci parameters to have different users, tasks, or locations. These changes can also occur within the same industry sector. This evolutionary process can occur in various forms such as all variations contained in modular segments within the application and accessed on-demand, the release of versioned products pushed by updates over the Internet, or the provision of a new product. This ensures the continuous customisation of the product to suit the user's needs.

An important aspect of this adaptability is the program's responsiveness to changes in the physical and virtual world. Thus, the user's immersive perspective updates in real-time and can encourage innovation (Rameshwar and King, 2023). As clarified in the next section, connecting the various elements can reduce the delay between changes. For example, the tourist and engineer visualise updated data that reflects changes to the building's information as conditions change. Such as moving to another part of the building changes the virtual image to show information specific to the current position.

4.11.2 Connected systems

This connectivity incorporates the physical and virtual domains. It "links the user to other virtual and/or physical systems that provide additional data" (Rameshwar and King, 2023). This purely digital or cyber-physical ability can facilitate continuous updates in real time. There is an exchange of information between the modular segments of the application that instructs them to change. It depends upon how the various components connect to the network, which provides their changes. For example, a change in the type of user can affect the specifics of the linked task. Thus, changing the user profile from tourist to engineer updates the task information from historical to BIM data. It can occur simultaneously as the user type changes. This feature benefits from interconnecting various decentralised segments. The following section outlines the importance of this key concept.

4.11.3 Decentralisation

The use of segmented parts in the XR application provides each part with a level of autonomy. This encapsulates all the properties and functionalities into the element. Therefore, modifications made to a specific element would not affect the others. This facilitates the ability to provide "multiple unique immersive experiences" using interchangeable design foci, which further promotes the project's evolution (Rameshwar and King, 2023). For example, changes to the user profile from a tourist to an engineer do not affect the task or location of virtually walking through the building.

This modular design also enables the parallel development of various parts of the application by different members of the project team. Thereby, effectively accelerating PoC development given enough human resources to complete the tasks.

However, the system will not function coherently if the individual components are unaware of their core functions. It should not allow incompatible elements to be connected. This could result in a distorted virtual experience, such as a tourist viewing BIM information or the engineer viewing the building's historical and cultural information. Therefore, the system requires a level of intelligence to decide upon approved changes based on specific requests as outlined below.

4.11.4 Intelligent

The application's ability to understand its function and the user's needs as the virtual and physical domains change is essential for an adaptive real-time immersive experience (Rameshwar and King, 2023). It relies upon real-time data to make decisions about the connected decentralised objects.

However, this may not be a core requirement of the XR application as adaptability can be simply data-driven once there is no need to make decisions (Rameshwar and King, 2023). For example, the change in persona data from tourist to engineer will create a change in the program from historical to BIM data. This does not require intelligence as the tourist persona links to the historical information and the engineer persona links to the BIM data. The system will still adapt depending upon the change. In another example, the engineer may require historical significance to contextualise the BIM data, especially if it involves the modification of a heritage building. An intelligent agent can understand the engineer's questions, have access to the building's history and BIM, and decide how to present a combination of the information (Thomas, 2019).

The intelligent agent may be artificial (as an AI) or a human-in-the-loop (such as a remotely connected engineer or data analyst). There is a distinction between an intelligent system and an automated system following pre-defined rules. The choice depends on the information derived from the integration of the horizontal and vertical value chains to meet the objective. The next section focuses on this aspect.

4.11.5 Integration of value chains

In the previous examples, the historical information provides value to the tourist and the BIM provides value to the engineer. This makes use of the vertical integration of value chains as raw data obtained from historical research studies and building sensors undergo various processing stages to become useable as an immersive experience. It benefits from an interconnected network that pushes updates to the end user from changes in the lower levels (such as new information from current research or new data from sensors). However, the engineer also benefits from combining the information developed for the tourist with the BIM data. This is the horizontal integration of the tourism value chain and the construction value chain. This provides variety to the design foci. It is the "seamless provision of pre-existing and new values" (Rameshwar and King, 2023). As such, this type of integration enables an evolution of the existing platform's functionality based on the user's need. It creates an innovative use of the platform and data. To function, it requires connectivity to the various decentralised data. This ability also exists in the parallel development of the segmented XR elements. Thus, the final project is an integration of the individual modular components based on linking their value chains to satisfy the objective. Therefore, the integration of value chains involves understanding the various parts of the system to select and connect the appropriate components to share value. This is only part of the I4.0 strategy. As mentioned earlier, the use of the STI4 label requires the clear identification of I4.0 or each key concept. The next section summarises this point using a table that includes all of the codes and their inclusion and exclusion criteria.

4.12 Codebook summary

Table 5 provides a summary of the codes identified for the development of an XR project from the concept to the PoC stage. It offers a quick and easy-to-use format to itemise the critical requirements needed to analyse a project throughout the development lifecycle. The following is a recommended three-step process for using this codebook.

1. Familiarise yourself with the codebook:
   - Study the codebook's comprehensive explanation of the codes used for analysing and assessing the development of XR projects
   - Pay close attention to the reason for the code, inclusion criteria, and exclusion criteria provided in the codebook
2. Apply the codebook to various development stages of an XR project:
   - Use the codes to prioritise the information to identify and assess
   - Assign appropriate codes based on the inclusion and exclusion criteria
3. Analyse and assess the coded information:
   - Evaluate the completeness and comprehensiveness of the coded data
   - Determine the reasons for missing codes and their impact on the project

- Identify improvements to the XR development process based on the missing codes
- Explore the possibility of comparing codes across multiple XR projects to identify patterns (recurring themes or elements) and trends (direction or changes over time) that can define emerging practices, best practices, or a combination of both

5. Conclusion

The demand for virtual systems increased due to the inability to access physical systems during the enforced isolation of the Covid-19 pandemic. This demonstrated a practical need for more XR projects that could solve this problem. As such, this paper produces a codebook to encourage and accelerate the advancement of any type of XR project across multiple industry sectors, enhancing innovation, competitiveness, and sustainability within a geographic region.

The codebook presented in this paper draws upon the XR development strategy outlined in the research paper "Analysis of Caribbean XR Survey Creates an XR Development Strategy as a Path to the Regional Metaverse Evolution". It serves as the foundation for identifying and categorising 24 specific codes that span the following domains: strategy and policy, financial, software, human resources, training, geographic, industry sector, design, UX, and I4.0.

Stakeholders can benefit from the codebook's systematic approach to XR development utilising a three-step process of code familiarisation, code application, and analysis and assessment. Furthermore, the concise codebook summary table aids in the efficient identification and application of the codes by presenting their rationale together with their inclusion and exclusion criteria.

There are three key benefits to using this codebook. The first is a proactive approach before the project starts. It facilitates any individual with an interest in developing an XR project to use the specific codes to identify the core requirements of the application, prioritise the factors of influence, ensure the availability of the appropriate resources, and select a suitable target market.

The second benefit is a work-in-process (WIP) analysis during the development phases. Creators can use the codebook to evaluate their ongoing initiatives and continuously identify areas for improvement or refinement. This provides an ability to be agile and adapt to dynamically changing market conditions or customer needs.

The third benefit occurs after the completion of the project. It is not specific to the creators. Thus, anyone can assess any application using this post-mortem analysis to identify specific areas to improve. The codebook focuses on specific development areas to provide actionable insights for new projects. This allows stakeholders to take strategic actions to optimise future XR developments.

Therefore, the codebook provides a tool that supports the planning, execution, and post-mortem phases of XR project development. It empowers individuals to make informed decisions, mitigate risks, and increase the overall success rate of their XR initiatives. This enhances future projects and fosters ongoing innovation within the XR industry.

5.1 Implications

This codebook provides both managerial and practical benefits. From the practical perspective, it provides users with a clear understanding of the development of each code and a guide for identifying suitable data to receive a label. The use of a common codebook facilitates collaboration among multiple researchers coding the same dataset. It provides an understandable framework for identifying data, selecting a code, and creating new codes. This process can reduce errors and inconsistencies in coding information. Additionally, a user can apply the pre-defined codes as part of a deductive coding process as they are specific to an XR development strategy and part of the ICT domain.

The managerial focus of the codebook pertains to the ability to quickly and easily identify critical elements of the XR development process. This improves the efficiency and effectiveness of creating the XR project. The strategic focus of the codebook aligns with management's goal of identifying and allocating required resources, monitoring the progress of the project, and evaluating the performance for areas of improvement. The structured format of the codebook allows management to evaluate their wider financial, organisational, goals and objectives with those of the XR development strategy by aligning various development activities. The codebook can also aid in the decision-making process by outlining critical factors to the development process.

5.2 Limitations of the study

This research focused on the identification and creation of codes specific to the development of XR projects. It provides a user with the ability to assess various stages of the project lifecycle. However, the researcher recognises the following limitations of the study that affect the integrity of the established codes. These points can assist future research work in this area.

- This study did not utilise a large dataset of papers to develop the codes. The source data was a single paper on a clearly defined agnostic XR development strategy. As such, this reduced the scope of discovering other potential codes that could affect the creation of XR projects.

- The focus on coding the XR development strategy created codes specific to the boundaries of the ICT domain.
- The researcher did not use multiple coders to reduce any bias or errors in developing the codes.
- No XR stakeholders validated the usability and understandability of codes within various parts of the XR development process.
- Open coding was the primary coding process to identify and codify clearly defined descriptive data. The researcher also applied limited axial coding to existing data hierarchies. As such, this limited the full exploration of relationships between categories. Additionally, the use of the following types of coding could improve the codebook: attribute, eclectic, pattern, categorisation, and exploring patterns across codes.
- Manual development of codes limited their scalability

5.3 Directions for further studies

The researcher recognises the limitations addressed in this study in the previous section and identifies the need for future improvement to strengthen the reliability and accuracy of the XR development codebook. As such, there are plans to conduct in-depth interviews with XR stakeholders to understand their opinions and perspectives on the existing codebook and XR development strategy. Additionally, future scholars can consider the following points to improve their codebooks and expand this area of research.

- Evaluate the applicability of codes in non-ICT development domains.
- Expand the dataset to include more papers focused on XR development strategies.
- Adopt software-based systems to code data as Computer–Assisted Qualitative Data Analysis Software (CAQDAS) (Kaufmann et al., 2020) and artificial intelligence Large Language Models (LLMs) (Chew et al., 2023; Xiao et al., 2023).
- Use a team of trained qualitative coders to assist in the development and evaluation of codes.
- Use additional coding techniques in addition to open and axial.

Table 5. Codebook Summary for XR Development and Analysis

Code	Code Name	Code Description	Reason for Code	Inclusion Criteria	Exclusion Criteria
ACFU	Funding to accelerate XR development	Monetary support that accelerates XR PoC development	Reduces time to complete PoC	Funding to accelerate PoC development	Funding not used to accelerate PoC development
ACTD	Training and development to accelerate XR development	Educational support for the project members that accelerates XR PoC development	Reduces time to complete PoC	Training targeted to accelerate PoC development	General training that does not accelerate PoC development
ACSO	Software to accelerate XR development	Software involved in various phases of the project to accelerate XR PoC development	Reduces time to complete PoC	Software easy to use to accelerate PoC development	Software that does not accelerate PoC development
ACHR	Human resources that accelerate XR development	Number and type of team members that accelerate XR PoC development	Reduces time to complete PoC	Human resources that accelerate PoC development	Human resources that do not accelerate PoC development
ENFU	Funding that encourages XR development	Monetary support that encourages XR PoC development	Encourage anyone to develop PoC and increase the number of PoCs	Funding to encourage anyone to develop PoC or to increase the number of PoCs	Funding that does not encourage anyone to develop PoC or that does not increase the number of PoCs
ENTD	Training and development that encourages XR development	Educational support for the project members that encourages XR PoC development	Encourage anyone to develop PoC	Training to assist anyone to develop PoC	Training does not encourage anyone to develop PoC
ENSO	Software that encourages XR development	Software involved in various phases of the project to encourage XR PoC development	Encourage anyone to develop PoC	Software easy to use to encourage anyone to develop PoC	Easy-to-use software that does not encourage anyone to develop PoC
ENHR	Human resources that encourage XR development	Number and type of team members that encourage XR PoC development	Encourage a group to increase the number of PoCs	Human resources that encourage the increase in the quantity of PoCs developed	Human resources that do not encourage the increase in the quantity of PoCs developed
GXXX	Geography (country or region) of focus within the scope of XR development	G, for geography, followed by code used for a specific country or region using the M 49 or ISO 3166 format	Country or region of focus for XR development	XR development focused on geographic area	No clearly defined geography focused on XR development
ENST	Strategy that encourages XR development	A holistic set of goals that encourage XR PoC development	Encourage anyone to develop PoC or increase the number of PoCs	Strategy that encourages XR PoC development	Strategy that does not encourage PoC development
ACST	Strategy that accelerates XR development	A holistic set of goals that accelerate XR PoC development	Reduces time to complete PoC	Strategy to accelerate PoC development	Strategy that does not accelerate PoC development
ENPO	A policy that encourages XR development	Set of decision-making factors that encourage XR PoC development	Encourage anyone to develop PoC or increase the number of PoCs	A policy that encourages XR PoC development	A policy that does not encourage PoC development

ACPO	A policy that accelerates XR development	Set of decision-making factors that accelerate XR PoC development	Reduces time to complete PoC	A policy that accelerates XR PoC development	A policy that does not accelerate PoC development
IXXX	The industry sector that is the focus of XR development	I, for Industry Sector, followed by code for a term based on UN ISIC	Industry sector of focus for XR development	XR development focused on the industry sector	No clearly defined industry sector focused on XR development
DFUS	Design focus user	Design focus user that is a part of the XR development process	Identification of design focus user to design XR PoC	Clear identification of who will use the XR application or the ability for anyone to use it	No clearly defined user identified
DFPU	Design focus purpose (task)	Design focus purpose (task) that is a part of the XR development process	Identification of design focus purpose to design XR PoC	Clear identification of the tasks the user performs with the XR application	No clearly defined tasks identified
DFLO	Design focus location	Design focus location that is a part of the XR development process	Identification of design focus location to design XR PoC	Clear identification of where someone will use the XR application or the virtualised environment used within the XR application	No clearly defined location identified
STI4	Strategy Industry 4.0 (I4.0)	Strategy Industry 4.0 that is a part of the XR development process	Identification of I4.0 or each of the key concepts to develop the PoC design	Incorporates the key concepts of I4.0, such as evolution, decentralised, connected systems, intelligent, integration of value chains	Only some of the key concepts utilised
STUX	Strategy user experience (UX)	Strategy user experience that is a part of the XR development process	Identification of user experience elements to develop the PoC design	Clear identification of experiences users achieve	No clearly defined experiences achieved
STFI	Strategy Financial	Strategy financial that is a part of the XR development process	Identification of financial requirements to develop the PoC design	Identification of the methods used to finance the XR development process	No clearly defined financial methods identified
STME	Strategy method development	The method used by the author to develop strategy, such as interviews, case studies, surveys, etc	Identification of the method used to create the XR development strategy	How authors developed the strategy	No information on how the authors developed the strategy
POME	Policy method development	The method used by the author to develop policy, such as interviews, case studies, surveys, etc	Identification of the method used to create the XR development policy	How authors developed the policy	No information on how the authors developed the policy
STYE	Strategy yes (present)	Set of goals that enables XR PoC development	Clear identification of any strategy present	Any strategy that enables XR development	No information about the goal
POYE	Policy yes (present)	Set of decision-making factors that enable XR PoC development	Clear identification of any policy present	Any policy that enables XR development	No information about who needs to do it, what needs to be done, where, when, why, and how to do it

References

Calmettes, M., Joatton, J.-B., Maudet, N., and Thollot, J. (2023). Exploring the untapped potential of text fields in creative software. In *Proceedings of the 34th Conference on l'Interaction Humain-Machine*, IHM '23, New York, NY, USA. Association for Computing Machinery.

Chang, Y.-n., Lim, Y.-k., and Stolterman, E. (2008). Personas: From theory to practices. In *Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges*, NordiCHI '08, pages 439–442, New York, NY, USA. Association for Computing Machinery.

Chew, R., Bollenbacher, J., Wenger, M., Speer, J., and Kim, A. (2023). Llm-assisted content analysis: Using large language models to support deductive coding. *arXiv preprint arXiv:2306.14924*.

Choudhary, L. (2022). 2022 is the year of text-to-anything. https://analyticsindiamag.com/2022-is-the-year-of-text-to-anything/.

Çolakoğlu, Ü., Anış, E., Esen, Ö., and Tuncay, C. S. (2023). The evaluation of tourists' virtual reality experiences in the transition process to metaverse. *Journal of Hospitality and Tourism Insights*, ahead-of-print(ahead-of-print).

DeCuir-Gunby, J. T., Marshall, P. L., and McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field Methods*, 23(2):136–155.

Dente, B. (2014). *Understanding Policy Decisions*, pages 1–27. Springer International Publishing, Cham.

Dinh, A., Tseng, E., Yin, A. L., Estrin, D., Greenwald, P., and Fortenko, A. (2023). Perceptions about augmented reality in remote medical care: Interview study of emergency telemedicine providers. *JMIR Form Res*, 7:e45211.

Faber, C. J., Kajfez, R. L., Lee, D. M., Benson, L. C., Kennedy, M. S., and Creamer, E. G. (2022). A grounded theory model of the dynamics of undergraduate engineering students' researcher identity and epistemic thinking. *Journal of Research in Science Teaching*, 59(4):529–560.

Hai-Jew, S. (2017). *Creating Inheritable Digital Codebooks for Qualitative Research Data Analysis*, pages 251–271. Springer International Publishing, Cham.

Hegde, S., Larsen, E., Torbett, O., Ponnala, S., Pohl, E., Sze, R., and Schaeubinger, M. M. (2023). A proactive learning approach toward building adaptive capacity during covid-19: A radiology case study. *Applied Ergonomics*, 110:104009.

Hidalgo, C. A., Balland, P.-A., Boschma, R., Delgado, M., Feldman, M., Frenken, K., Glaeser, E., He, C., Kogler, D. F., Morrison, A., Neffke, F., Rigby, D., Stern, S., Zheng, S., and Zhu, S. (2018). The principle of relatedness. In Morales, A. J., Gershenson, C., Braha, D., Minai, A. A., and Bar-Yam, Y., editors, *Unifying Themes in Complex Systems IX*, pages 451–457, Cham. Springer International Publishing.

Hirzle, T., Müller, F., Draxler, F., Schmitz, M., Knierim, P., and Hornbæk, K. (2023). When xr and ai meet - a scoping review on extended reality and artificial intelligence. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI '23, New York, NY, USA. Association for Computing Machinery.

Ho, J., Chan, W., Saharia, C., Whang, J., Gao, R., Gritsenko, A., Kingma, D. P., Poole, B., Norouzi, M., Fleet, D. J., et al. (2022). Imagen video: High definition video generation with diffusion models. *arXiv preprint arXiv:2210.02303*.

Houghton, C., Murphy, K., Meehan, B., Thomas, J., Brooker, D., and Casey, D. (2017). From screening to synthesis: using nvivo to enhance transparency in qualitative evidence synthesis. *Journal of Clinical Nursing*, 26(5-6):873–881.

Impedovo, M. A., Ritella, G., and Ligorio, M. B. (2013). Developing codebooks as a new tool to analyze students' eportfolios. *International Journal of EPortfolio*, 3(2):161–176.

ISO, n.d. (2023). Iso 3166 — country codes. https://www.iso.org/iso-3166-country-codes.html.

Kang, S. and Kang, S. (2019). The study on the application of virtual reality in adapted physical education. *Cluster Computing*, 22(1):2351–2355.

Karre, S. A., Mathur, N., and Reddy, Y. R. (2019). Is virtual reality product development different? an empirical study on vr product development practices. In *Proceedings of the 12th Innovations on Software Engineering Conference (Formerly Known as India Software Engineering Conference)*, ISEC'19, New York, NY, USA. Association for Computing Machinery.

Kaufmann, A. A., Barcomb, A., and Riehle, D. (2020). Supporting interview analysis with autocoding. In *Proceedings of the 53rd Hawaii International Conference on System Sciences | 2020*. 752–761.

Khaerati, K. (2016). The students' perception on the characteristics of effective and ineffective english language teachers. *ELT Worldwide: Journal of English Language Teaching*, 3(2):221.

Khan, A., Sepasgozar, S., Liu, T., and Yu, R. (2021). Integration of bim and immersive technologies for aec: A scientometric-swot analysis and critical content review. *Buildings*, 11(3).

King, G. S., Rameshwar, J. R., and Syan, C. S. (2020). Industry 4.0 in a small commodity-based economy: A vehicle for stimulating innovation. *Journal of Industrial Integration and Management*, 05(03):365–391.

Liu, V. and Chilton, L. B. (2022). Design guidelines for prompt engineering text-to-image generative models. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, pages 1–23.

Loutoo, J. (2021). Uwi secures us$25 million technology grant. trinidad and tobago newsday. https://newsday.co.tt/2021/04/05/uwi-secures-us25-million-technology-grant/.

Matthews, B., See, Z. S., and Day, J. (2021). Crisis and extended realities: remote presence in the time of covid-19. *Media International Australia*, 178(1):198–209.

McGinn, J. J. and Kotamraju, N. (2008). Data-driven persona development. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '08, page 1521–1524, New York, NY, USA. Association for Computing Machinery.

Nassereddine, H. M. (2019). *Design*. Development and Validation of an Augmented Reality-Enabled Production Strategy Process for the Construction Industry [UNIVERSITY OF WISCONSIN–MADISON].

Niko, G. (2023). The use of gpt chat ai in blender code creation. https://medium.com/\spacefactor\@m{}Eleron/the-use-of-gpt-chat-ai-in-blender-code-creation-f4488ed677b4.

Nopanen, V. (2022). Text to anything is changing content creation. https://mymetaverseday.com/2022/11/30/text-to-anything/.

OAS (2021). Oas and meta partner to train thousands of latin american and caribbean creators in augmented reality. https://www.oas.org/en/media_center/press_release.asp?sCodigo=E-116/21.

Polygoningenieur (2023). Chat companion. https://blendermarket.com/products/chat-companion.

Poole, B., Jain, A., Barron, J. T., and Mildenhall, B. (2022). Dreamfusion: Text-to-3d using 2d diffusion. *arXiv preprint arXiv:2209.14988*.

Popoola, O. O. (2016). Actors in decision making and policy process. *Global Journal of Interdisciplinary Social Sciences*, 5(1):47–51.

Pruitt, J. and Grudin, J. (2003). Personas: Practice and theory. In *Proceedings of the 2003 Conference on Designing for User Experiences*, DUX '03, page 1–15, New York, NY, USA. Association for Computing Machinery.

Puentes-Markides, C. (2007). Policy analysis and decision-making with emphasis on chronic non-communicable diseases. https://www3.paho.org/english/ad/dpc/nc/cmn-po-bar-7-1-pol-perspectives.pdf.

Rajaram, S., Chen, C., Roesner, F., and Nebeling, M. (2023). Eliciting security & privacy-informed sharing techniques for multi-user augmented reality. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI '23, New York, NY, USA. Association for Computing Machinery.

Rameshwar, J. R. and King, G. S. (2020). Case studies in engineering and technology innovation in the caribbean: A focus on educolcom and bevcom. In Chowdary, B. V., editor, *Proceedings of the International Conference on Emerging Trends in Engineering & Technology (IConETech-2020)*. 574–584, Faculty of Engineering The University of the West Indies, St. Augustine.

Rameshwar, J. R. and King, G. S. (2022). Caribbean metaverse development: A literature review perspective. *Journal of Metaverse*, 2(2):83 – 99.

Rameshwar, J. R. and King, G. S. (2023). Analysis of caribbean xr survey creates an xr development strategy as a path to the regional metaverse evolution. *Journal of Metaverse*, 3(1):43 – 65.

Rauschnabel, P. A., Felix, R., Hinsch, C., Shahab, H., and Alt, F. (2022). What is xr? towards a framework for augmented and virtual reality. *Computers in Human Behavior*, 133:107289.

Rubio-Tamayo, J. L., Gertrudix Barrio, M., and García García, F. (2017). Immersive environments and virtual reality: Systematic review and advances in communication, interaction and simulation. *Multimodal Technologies and Interaction*, 1(4).

Skjott Linneberg, M. and Korsgaard, S. (2019). Coding qualitative data: a synthesis guiding the novice. *Qualitative Research Journal*, 19(3):259–270.

Swift, K. K. (2017). *ICT4D policy for Trinidad and Tobago: discursive constructions*. PhD thesis, University of Sussex Business School.

The Khronos Group Inc. (2020). Openxr overview. https://www.khronos.org/openxr/.

Thomas, J. and Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*, 8(1):45.

Thomas, M. D. (2019). Intelligent realities for workers using augmented reality, virtual reality and beyond. *IIC J. Innov*, pages 1–18.

Tiwari, S. (2016). An introduction to qr code technology. In *2016 International Conference on Information Technology (ICIT)*, pages 39–44.

Turakhia, D. G., Ludgin, D., Mueller, S., and Desportes, K. (2023). What can we learn from educators about teaching in makerspaces? In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI EA '23, New York, NY, USA. Association for Computing Machinery.

United Nations (2008). International standard industrial classification of all economic activities revision 4. https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf.

United Nations Statistics Division (2023). Methodology standard country or area codes for statistical use (m49). https://unstats.un.org/unsd/methodology/m49/.

Vaismoradi, M., Turunen, H., and Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences*, 15(3):398–405.

Vasarainen, M., Paavola, S., and Vetoshkina, L. (2021). A systematic literature review on extended reality: Virtual, augmented and mixed reality in working life. *International Journal of Virtual Reality*, 21(2):1–28.

Versy FZCO (2023). Transform text into virtual experiences. https://www.versy.ai/.

Wiggers, K. (2022). Openai releases point-e, an ai that generates 3d models. https://techcrunch.com/2022/12/20/openai-releases-point-e-an-ai-that-generates-3d-models/.

Williams, R. M. (2020). *Metacogs: VR Toolkit for Executive Function Assessment and Metacognitive Strategy Development via Agent-Based Modeling*. PhD thesis, University of Florida.

Xiao, Z., Yuan, X., Liao, Q. V., Abdelghani, R., and Oudeyer, P.-Y. (2023). Supporting qualitative analysis with large language models: Combining codebook with gpt-3 for deductive coding. In *Companion Proceedings of the 28th International Conference on Intelligent User Interfaces*, IUI '23 Companion, page 75–78, New York, NY, USA. Association for Computing Machinery.