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# Time and futures. Analysis of time-needs in futures research

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## Abstract

This paper discusses temporalities in futures research in terms of a novel notion of time-need. It is argued that this notion contributes to the theoretical and critical discussion about time in futures research. The paper uses as an illustrative case study a railway transportation system to highlight how different actors within a system have unique temporal needs that shape their perceptions, actions, and relation to the future. The authors discuss the interplay of power, control, utilization, and the strategic manipulation of temporal information. This paper argues for a novel conceptual approach to temporal phenomena that can be used to (i) understand and plan a technological system better, but also (ii) provide critical reflection on the power and control implicit in such systems. Moreover, the paper suggests that futures research as a field has its own time-needs that shape how it approaches the future. Recognizing these time-needs enables a more nuanced understanding of futures research. Scenarios, knowledge, and power are all intimately related to time.

**KEYWORDS**

time, temporality, time-need, time resources, power, futures knowledge, time measurement, time representation

## 1 | INTRODUCTION

Time and how time is understood are at the core of futures research. Some of the most fundamental works in the field call for closer scrutiny in the discussion about time, its role in human lives and future making. Yet, there are only scattered discussions about the topic, and they tend to discuss conceptions of *time* as a rather abstract phenomenon. Most of the discussions concern how time and temporality shape what timescales are studied, and next to nothing has been said about how futures research as a practice itself is related to time. In this paper, we argue that futures research should (i) pay more attention to how the people and systems it studies are related to time in various ways, that is, have differing time demands, time measurements, utilization of time, timing of events, and so on, and (ii) how the field itself has different relations to time with respect to the elements mentioned in (i).

Key works in the field have challenged time notions that define western modernity and, thereby, also futures research.[1] In this paper, we take somewhat different approach. We analyze an area where the western modernity manifests itself in one of its most crystallized and original forms: the train traffic. The construction of railways and railway traffic was a crucial part of the creation of the modern society and its economy. We argue that even in this case, time and people's relation to time are very complex and rather opaque. This suggests that the issue of time and temporality in futures research could be deeper than realized. If time and temporality are complex even at the heart of western modernity, one can only imagine how complex they are across different contexts. To gain critical and reflective understanding of time and temporality, however, is possible also in a "familiar" techno-social context.

We systematize the discussion about time by introducing the notion of a *time-need*. The notion captures how different actors,

systems, and other elements connect to the inherent temporal needs of human lives and activities. This notion encompasses several dimensions, such as differing time demands, time measurements, utilization of time, timing of events, control over other actors' conceptions of time, and managing time experience and its effects on behavior. We explain these dimension in more detail in Section 3. Note that *time-need* refers not only to varying time requirements for different activities. Rather, the notion refers to all those aspects of human lives and activities (and technological phenomena associated with them) that are related to how time is used, cognized, and controlled. Moreover, different people and systems have different time-needs, and these interact with each other. Some of the most interesting interactions stem form colliding time-needs and the discoordination that such collisions create in human lives.

We proceed as follows. In Section 2, we discuss the critical takes on time and temporality in futures research and related fields. We point out that the study and problematization of time has not been taken far enough in the field. In Section 3, we discuss the notion of *time-need* and how it reveals roles that time and temporality have in human lives. In Section 4, we discuss a case study on VR Group's public transportation operations that highlights the role of time especially in data acquisition methods, system compatibility, and the importance of accurate timing. In Section 5, we discuss how the case and the related issues in time-need are relevant to the core issues of futures research. In Section 6, we discuss how the study of time and temporalities can strengthen the core tenets of futures research. In Section 7, we analyze the time-needs of futures research itself using Causal Layered Analysis (CLA). In Section 8, we provide a structured process for futures practitioners to assess and manage time-needs when planning futures/foresight interventions within organizations.

## 2 | PROBLEMATIZING TIME IN FUTURES RESEARCH

In futures research, time is a fundamental issue. *The future* is temporally defined, and its creation is a temporal process. Bell (2009, 140–142) even asserts that a linear and unidirectional time conception defines futures research and links it to the promise of future novelties. These novelties and their accumulation cannot be made sense of without linear and unidirectional conception of time. Because the passage of time creates novelties and because these novelties create the characteristic challenges for futures research—"with rapid change our cognitive maps of the past and present may be so out of date that they no longer are accurate or even recognizable representations of the future" (Bell, 2009, 142)— the passage of time and temporality need to be understood and managed conceptually. Bell discusses the meanings of time and argues that "[u]nderstanding the measurement and meaning of time is absolutely basic to futures thinking" (2009, 162).

This perspective is not unique in the field. Many authors have scrutinized time and temporality. Often, the discussions center on temporal scales in futures research and motivations behind them, such as scientific, practical, and political motivations (e.g., Brier, 2005; Nordlund, 2012). Moreover, Bauer argues that "With the limitation of the future time that is considered, authority and control over the 'content' of the future is exerted, that is, possibilities for particular images of the future and related courses of action are opened up and closed down" (2018, 43). The focus on timescales as a source of identity, challenges, and power in futures research have been discussed.

However, the most critical tones suggest the field should question notions of *time*, not just approved temporal scales. Inayatullah argues that "an ideal theory of the future must be able to problematize time and to negotiate the many meanings of time" (1993, 235). Inayatullah also argues that a critical perspective on time can make the past, and the uses of the past, problematic (1993; 1998b). Milojevic argues that time should be re-invented. Milojevic argues that "clock time was at one time 'invented' [--] to respond to the needs and desires of a particular society/culture/civilization/gender" (2008, 333). Interestingly, the conception of time stems from western modernity: "Capitalism, industrialism and colonialism, as well as patriarchy, helped with a construction and an imposition of such an approach to time" (Milojević, 2008, 333). This type of insight was also provided already by Thompson (1967) who argued that the rise of industrial capitalism led to a new emphasis on time management, standardization, and discipline. However, what is important for futures research is that, because this conception of time does not serve to overcome the current challenges, new conceptions of time need to be invented to overcome them (Milojević, 2008, 334). Similar feminist treatments of time and temporality are not a novel phenomenon but can be found, for example, from Kristeva who situated "the problematic of women in Europe within an inquiry on time" (Kristeva, 1981, 15).

There seems to be something missing in between these analyzes. They either focus on inherent linear timescales in futures research or challenge temporal orientations in western societies *in toto*. In contrast, we argue that there is a need for more detailed analysis of time that focuses on many aspects of time and temporality that ground and affect human and nonhuman activities and their interactions. To show how nuanced the topic is, we focus on a system—railroad traffic—that is quite symbolic of the western modernity. Our argument is that, given that phenomena related to time and temporality can be reconsidered and critically reflected on even in the confines of this system symbolizing western modernitiy, one can only imagine how much work there is to be done on time and temporality in divergent contexts.

Railroad traffic relates uniquely to conceptions of time. Marrs (2008) has analyzed how the development of railroads in the Antebellum South (the Southern United States during the period before the American Civil War) transformed time consciousness. The railroads contributed to the shifting of society from a flexible, task-oriented approach to a more clock-oriented understanding of time. Interestingly, the geographical area was not characterized by industrial capitalism (Marrs, 2008, 435). Moreover, railroad traffic is a phenomenon where many issues that are relevant to the

problematizing time and its role in human reality can be found in a visible form. For the purposes of this paper, the conclusion of Marrs is worth citing at length:

> "While time was important, the clock did not rule all. Rather, the railroad had to address and operate on *multiple times*…. Debates about time and the railroad were debates about *power*: who controlled when the train departed, where it alighted, and how often it arrived. … Although railroads are often linked in the popular imagination with timetables and other trappings of clock consciousness, antebellum southern railways actually wove *varieties of time* throughout the *infrastructure* necessary for a modernizing society. E. P. Thompson was surely right to point to time as a crucial way of understanding changes wrought by industrialization. Yet, by recognizing the myriad and interlocking ways that overlapping *cultures of time* conditioned and influenced railroad operations, [we] can fully appreciate the *analytical power of time* as a way to better understand these changes." (Marrs, 2008, 452–453, emphasis added).

As we will see in the sections to come, these types of phenomena occur even in the current railway systems. We argue that the notion of *time-need* is one way to capture and conceptually manage the phenomena.

To be sure, complexities of time and the struggles that center around time and temporality have been studied in different contexts (see Adam, 1990 discussing the canonical studies) and all the nuances cannot be discussed in one paper. However, a crucial line of thought is that time is not merely a background for what happens and what is done. Rather, how time operates is a production of the events and actions. For example, Latour (2005) argues that time's flow is shaped by human-nonhuman interactions, with the relationships themselves being of primary importance, not the flow. Also, time has a twofold role in social life. It is "produced by, and productive of, the relations and processes it operates through" (Harris & Coleman, 2019, 604). Emirbayer and Mische argue that human agency can be understood only through temporal nature of human experience: "As actors move within and among … different unfolding contexts, they switch between (or 'recompose') their temporal orientations—as constructed within and by means of those contexts—and thus are capable of changing their relationship to structure" (1998, 964). However, one should never forget how power binds with time (Freeman, 2022; Zerubavel, 1981) and, thereby, shapes the agency.

Moreover, events and activities involve a plurality of temporalities. Human practices and activities involve multiple temporalities simultaneously (Goodwin, 2002). Nowotny (1994) suggests that changes and increasing complexity in the current world lead to a fragmentation of time and the emergence of multiple conflicting temporalities. Also, Hassan suggests that "temporality and knowledge are not singular, universal 'things', but instead are processes, techniques, understandings and experiences that are marked by diversity and multiplicity that suffuse and help shape our being-in-the-world" (2003, 227). Because temporality "provides content and form to the kinds of knowledge that are produced" (Hassan, 2003, 228), it follows that different temporalities imply different forms of knowledge.

In futures research, detailed analyses of time are vital. First, *the future* is a time-related notion that requires acknowledgment of temporal plurality and its operations. These elements form the processes creating the future. Interestingly, it has been pointed out elsewhere that "Actors are always living simultaneously in the past, future, and present, and adjusting the various temporalities of their empirical existence to one another [--] in more or less imaginative or reflective ways" (Emirbayer & Mische, 1998, 1012). Not only do multiple temporalities influence the formation of the future, but the future as conceived by the actors plays a vital role in shaping these temporalities.

Second, as was already touched upon, time is intimately connected to knowing:

"Many things we know, we know in a particular time or timeframe. For knowledge of events and knowledge of rhythms and regularities, the connection to time is even self-evident. Also, time orders how people tell stories and convey knowledge. -- Time is itself an object of knowing. It circulates in our knowledge, and we construct and manipulate it. We theorize it, but we also fix specific meanings of time by the knowledge we consolidate." (Valkenburg, 2023, 442.)

The epistemically relevant aspects of time are crucial to futures research. It focuses on rhythms, regularities, patterns, and narratives. Bauer has argued that "time horizons are strongly linked to the possibility and methodology of knowing the future" (2018, 40); Inayatullah argues that "the search for the grand patterns of history and the identification of each one of our models of change" (2008, 10) is one of the main pillars of futures research; and just a quick glance at post-structural and critical futures research shows the importance of stories in peoples' conceptions of the future (see Inayatullah, 2008). Moreover, futures research centers on the idea that humans shape their future. The fact that different ways of acting towards the future affect the *when* of that future (consider the varied responses to climate change and their effects on when disaster strikes) makes it clear that how time and timescales are managed should be analyzed.

In what follows, we introduce the notion of *time-need* as an analytic and philosophical concept to (i) problematize time in futures research, (ii) give insights into how time is constituted by human and nonhuman practices, and (iii) clarify the role of multiple temporalities in forming reality. Already Luhmann (1976) noted that societies have particular ways of organizing and perceiving time. He suggests that our time measurement and life alignment are naturally occurring. Distinct societies, even organizations within them, construct time differently, and this is influenced by their needs and context. We agree on the abstract level, but we attempt to make the discussion more nuanced and articulate the relationship between needs and

time in terms that are relevant and tailored to the field of futures research.

## 3 | THE NOTION OF *TIME-NEED*

In this section, we explicate the notion of *time-need*. *Time-need* is a new notion that explicates how needs, goals, beliefs, and values influence people's engagement with time. In other words, the notion captures the connections between actions and time: We need time; we need to measure time; we need to represent time; we need to cognitively and technologically process time; we need to time actions and events; we need to control time; we need to experience time. By examining various aspects of the notion of *time-need*, we can gain a deeper understanding of our relationship with time in diverse contexts. In this section, we discuss the different components (or aspects) of *time-need*. We apologize the abstract nature of the initial discussion. In the next section, we discuss the notion with respect to a case study.

The notion of *time-need* captures the following phenomena, presented by Table 1 and explicated below:

*How much time is needed in a process*. The first aspect relates to the duration required for processes. Different tasks and activities take varied lengths of time to complete. Effective action and goal achievement depend on understanding this temporal necessity. Aspects like personal preferences, resources, technology, and societal expectations shape this component of *time-need* and influence how human and nonhuman systems manage schedules and priorities.

*Measurements of time*. The second aspect of *time-need* relates to time measurement and its importance for actions. Timekeeping is a central element in human activities and technological processes. However, the precision—and the meaning of "precision"—of time measurement is context-specific and can vary depending on the task at hand. *Time-need* emphasizes the importance of access to appropriate time-measuring tools and systems. Still, in reality, actions are coordinated using suboptimal time measurement methods due to resource and tool limitations.

**TABLE 1** The aspects of time-need.

| | |
|---|---|
| **Duration** | How much time a process requires. |
| **Measurement** | Importance of timekeeping for actions. |
| **Representation** | How time is visualized and perceived. |
| **Application** | Role of time in decision-making, planning, and operations. |
| **Coordination** | Timing actions, events, and processes. |
| **Control** | Influencing how others use and represent time. |
| **Power Dynamics** | Connection between time control and power. |
| **Subjective Experience** | Personal perception and impact of time. |

*Representations of time*. Representations of time are crucial for complex activities and coordination. Units, visualizations, and cognitive processes shape how we perceive and utilize time. Various actors and systems employ different methods to represent time. The representations of time help human and nonhuman systems conceptualize temporal relationships and coordinate activities. Moreover, technological devices' time representations impact system functionality and human/nonhuman interaction.

*Measurement and representation of time in decision-making, planning, and system operations*. Time measurements and representations, once in place, play a crucial role in various operations and inferences. Their application depends on the specific context and purpose they serve. Incorporating time measurements and representations is important for decision-making, scheduling, and planning processes across industries, institutions, and technological systems. For example, accurate temporal information is needed for making reliable predictions, conducting analysis, and executing tasks. Moreover, where and why the representations and measurements are planned to be used affects how the measurements and representations are conducted and built. Measurements, representations, and their intended uses are triangulated in different activities.

*Coordinating timed actions, events, and processes*. Timing actions, events, and processes at appropriate moments is important. Coordination and goal achievement in both human and nonhuman systems rely on the ability to time actions and events accurately. Developing timing skills and mechanisms has a profound impact on how activities are conducted. However, the ability to time actions and events is contingent upon the measurement, representation, and processing of time. Coarse-grained measurements or vague representations make accurate timing more challenging. Yet, context plays a significant role in determining the required level of precision for timing events and actions and, for example, punctuality is not equally important in every context.

*Controlling time management and representations in human and nonhuman actors*. Another aspect of *time-need* involves the attempts to control or influence how other actors use, represent, and process time. This can manifest in various ways, for example as setting deadlines, negotiating schedules, and establishing shared timelines. Controlling others' use of time is needed for coordination, resource management, and shared goal achievement. Communication, negotiation, and synchronization are needed when activities are related to complex structures of time. However, it is necessary to acknowledge the controversial side of time control, as it can be linked to power and potentially coercive actions. Controlling others' scheduling, thinking, and time measurements can be used to exert control without a shared goal in mind. It can be coercive.

In general, power and time-needs are intimately connected. The ability to measure, represent, and allocate time effectively can significantly impact an individual, group, or system's role and status in relation to others. Those with power often have control over time-related aspects of actions. Conversely, those who control time, its representations, and measurements often have power in other domains as well. *Time-need* incorporates various temporal dynamics

such as allocation, measurement, representation, and coordination, all of which contribute to power relations. This interconnectedness of time and power underlines the importance of conceptually recognizing and managing issues related to time if our reflections on time are to stand on ethically sustainable grounds.

*The subjective experience of time and its impact*. Finally, *time-need* addresses the subjective experience of time in human contexts. Experiences are influenced by factors such as representations of time, expectations, context, and emotions. In both social and personal settings, our perception of time may vary, impacting our ability to manage time effectively. *Time-need* emphasizes the importance of recognizing these subjective experiences.[2]

To sum up, *time-need* provides a framework for understanding time in various contexts, encompassing human and nonhuman systems. It captures our desire to comprehend, manage, and use time as a fundamental resource. *Time-need* captures the complexities of time and temporality, recognizing that time is not merely a backdrop but a product of activities and actions. It highlights the interplay between time, human activities, power dynamics, and the temporal nature of human experience. As actors move in-between different contexts, their temporal orientations and relationships to structures change, and this can be categorized by different aspects of time-need (See Section 2).

*Time-need* also acknowledges the presence of multiple temporalities in human practices which often overlap, intersect, and sometimes clash, and, therefore, require management and synchronization. These temporalities actively contribute to the production and application of knowledge. The allocation and control of time can be seen as a form of power, where dominant actors influence the temporal rhythms of others, impacting knowledge creation and sharing. Understanding *time-need* in its plurality deepens our understanding of the interplay between time, knowledge, and power.

Finally, there are, of course, multiple interconnections between different aspects of time-need and we cannot fully discuss this combinatorics exercise in the space of this paper. Table 2 below presents some interconnections between different aspects of *time-need*.

## 4 | THE CASE STUDY

Moving on to our case study, we will examine a practical application of *time-need* in a real-world system, that of railway transportation. Keep in mind that railway transportation has been thought as a canonical, familiar, and transparent context for clock-time.

The objective of the initial study was to conduct anthropological observation of the activities at the 200-person operating center for the Finnish Railway (VR Group), which oversees all train operations in Finland. Three months were spent on ethnographic observation. Additionally, we performed in-depth interviews to fully understand the functionality and operation of the Management Information Systems (MIS) used by the VR Group. The VR Group's headquarters, Helsinki Pasila, is where the operation center is located. Obtaining clearance to conduct research on Finland's highly secure, sensitive, and important infrastructure was challenging. As a result, we are unable to provide highly specific information about the MIS and its devices in this paper. The temporal dependencies and tools that determine the timing and location of Finnish train traffic are the main focus.[3]

**TABLE 2** Interconnections between different aspects of time-need.

| Aspect of time-need | Interconnections with other aspects |
|---|---|
| *Time needed for processes and actions* | - Affects ability to coordinate timed actions, events, and processes - Shapes representations of time needed for processes - Influences control over time management of other actors |
| *Time measurement* | - Determines accuracy of coordinating timed actions and processes - Enables processing measurements for decision-making and planning - Provides basis for controlling time management of other actors |
| *Representations of time* | - Shaped by time needed for processes and actions - Based on time measurements - Enables processing representations for decision-making and planning - Influences subjective experience of time |
| *Processing measurements and representations for decision-making and planning* | - Relies on time measurements and representations - Guides coordination of timed actions and processes - Enables control over time management of other actors |
| *Coordinating timed actions, events, and processes* | - Depends on time needed for processes and actions - Requires accurate time measurement - Guided by processing measurements and representations - Enables control over time of other actors |
| *Controlling time management and representations of other actors* | - Shapes time needed for processes of other actors - Relies on own time measurement and processing capabilities - Influences others' coordination of timed actions - Affects others' subjective experience of time |
| *Subjective experience of time* | - Influenced by measurement and representations of time - Shaped by others' control over time management |

Our research revealed considerable challenges associated with managing location and time data in public transportation within the VR Group's operations. We directed our focus towards error situations, such as power outages or GPS signal loss, to gain a more nuanced understanding of these complexities. One of the key areas of our study was the difference between physical and digital methods of obtaining location data. Physical devices like mechanical track circuit units and axle counters delivered accurate location data, but with significant delay due to their broad intervals of more than 40 kilometers. Conversely, digital sources like GPS supplied data in real-time, but the accuracy was not high (Table 3 below summarizes the systems).

Within the context of Finnish train traffic, our study illuminated the interplay of time, space, and data. This revealed critical insights about public transportation systems. Many insights arise from distinguishing between three dimensions of time: absolute, descriptive, and relative. *Absolute time* is the chronological progression of events within the physical infrastructure. It is like the ticking of a universal clock which is independent of individual perceptions and experiences. It moves at a steady pace, punctuating the rhythm of departure and arrival times for trains. *Descriptive time*, on the other hand, consists of digital representations of time. It is an abstraction that forms a timetable or schedule. It translates the complex dynamics of railway operations into a linear narrative that passengers and operators can easily comprehend and follow. *Relative time* is a unique blend of physical, digital, and interpretive elements. It is *relational* because it hinges upon the interplay of individual experiences, perceptions, and contextual factors, and thereby makes time a subjective and variable experience rather than a fixed, objective entity. It is inherently tied to spatial locations, static and moving infrastructures but also influenced by the understanding of the operations center staff and the passenger's personal requirements. Relative time also encompasses the subjective perception and experience of time during a journey which may vary considerably from one passenger to another.

Just as there are three dimensions of time, we also identify three corresponding spatial locations. The physical world of railway operations is rooted in absolute spatial locations—the railway tracks, stations, and other infrastructures. These static entities form the foundational structure of the railway system. Descriptive locations are digital representations, such as GPS data, that overlay the absolute locations and seeks to provide real-time details about train movements. They offer a dynamic map that helps the operation center to understand and manage the railway operations. Relative locations merge physical, digital, and interpretive data. They are defined in terms of the intersection of static infrastructures, dynamic digital data, and individual perceptions, and, therefore, capture the complex nature of a transportation system. Within the context of this specific Finnish train traffic study, *relative locations* refers to the combination of data about the physical space of the trains (absolute spatial location), the digital tracking information about the trains' positions (descriptive location), and the interpretation of this data by operations center staff and passengers. This composite data not only tells us where a train is physically or according to GPS, but it also provides insights into how that location is understood and acted upon by people involved in, or affected by, the system, for example, when they are making operational decisions or planning personal traveling schedules.

These different layers of time and space pose straightforward challenges in coordinating and understanding the data. The dynamic nature of these elements, together with the incompatibility among various formats of information, complicates accurate understanding of a train's location at any given time. The challenge becomes even more clear when we consider the unreliable nature of GPS data, particularly in regions like Lapland and Eastern Finland, where mechanical location devices are scarce. Operators, who heavily rely on GPS data for efficient operations and communication with passengers, face significant difficulties due to these discrepancies when GPS does not work. In general, our findings indicate that managing rail traffic using solely GPS is a complex task. Numerous factors, including safety devices, control devices, weather conditions, and more, can substantially influence train traffic and the location of trains. This complexity further underlines the importance of understanding and effectively managing the multiple realities created by different information systems.

Moreover, we found that current transportation systems tend to prioritize tracking the movement of trains rather than enhancing or personalizing passengers' mobility experiences. Since the systems lack interaction with passengers' mobile devices, they are unaware of passengers' locations, creating a gap in service personalization that might affect the quality of customer service. This also impacts on whose preferences shape the system.

**TABLE 3** Multiplicity of location data in Finnish train transportation information systems.

| Type of the location data | GPS data attached to locomotives | GPS data from media devices (tablets) carried by engine drivers | Electrical track circuits | Axle counter | Train transport signaling control system |
|---|---|---|---|---|---|
| **Source of location data** | GPS | GPS | Track electricity circuit | A physical device attached to track | Digital devices in applicator centers |
| **Spatial dimension** | Locomotive | Tablet | Iron bar | Iron bar | Railway station |
| **Temporal dimension** | Real time | Real time | Delay | Delay | Input/output |
| **Movement** | Real time | Real Time | Delay | Delay | Before the movement of a train |

All the insights above come into sharper focus when we consider the impact of an unexpected halt in a train's movement. The descriptive time, representing the schedule or timetable, is disrupted. Passengers might perceive time as standing still as the progression of their journey, as dictated by the timetable, comes to a halt. This disruption in the scheduled flow of events leads to a contrast between the planned journey and the passengers' experience. On the other hand, the relative time—the passenger's personal perception of time—might convey a different experience. A passenger who is running late for a meeting might feel time is speeding up, even though the train is static. The physical reality of the situation contrasts with the passenger's perceived reality and, thereby, adds to the complex layers of time management within the system. Meanwhile, absolute time—the chronological progression in the physical world—continues undisturbed and serves as a constant against the variable experiences and interpretations of time. This variability in the perception and experience of time highlights the need for an understanding of the multi-dimensionality of time.

In conclusion, understanding the relations between the nature of time, space, and systems in Finnish train traffic requires a nuanced approach, and the concept of time-need could provide a valuable perspective to address these relations. Our study suggests that there is an urgent need for innovative methodologies and data sources that set the stage for more effective management of public transportation systems in the future. *To plan for the future time, we need to understand time as it exists in every situation*. Even though the notion of *time-need* is first and foremost a conceptual and philosophical tool, we can see that it can have implications that reach a rather practical level.

To transition from our outline of the case study to an in-depth discussion, we need to notice how different aspects of the transportation system, such as differing mechanisms of location tracking, have a direct bearing on the notion of *time-need*, especially in managing the future in real-time systems. Central to our discussion is the acknowledgment that systems do not operate in a vacuum. Rather, their working and outputs are tied to the processes' temporal structure and the context of time measurement. Moreover, the representations of time vary across contexts and systems and this influences data interpretation and overall operational outcomes. Consequently, we must consider the role of measurements and representations of time in decision-making, planning, and system operations. The integrity and timeliness of location data can directly impact critical decisions, and in this way demonstrate the importance of time-need in operational decision-making. As we proceed in our discussion, we will also discuss how the necessity of coordinating timed actions, events, and processes indicates the importance of timing in the successful operations. Lastly, we will analyze how the control of time, in terms of management and representation, manifests across human and nonhuman agents in the system, making the control and power aspects of *time-need* visible. These aspects can be clarified once we discuss the case in terms of components of *time-need*.

*Time needed for processes and actions*: Train traffic and its planning are based on the fact that trains need certain amount of time to travel certain distances. Everything else, including measurement, representation, and processing of time are in place to make these movements possible. However, there are even more subtle ways in the system depends on how much time its elements require to fulfill their function. Mechanical track circuit units provide location information after a train has passed a specific point. The axle counting device measures the number of carriages that have passed a given point, and GPS provides more continuous, real-time geolocation data. Each of these systems operates at different speeds and provides data at different intervals. These varying time intervals directly impact operational efficiency. For example, if data from mechanical devices arrive with significant delays, it could disrupt schedules and possibly cause further delays in the network. Hence, the time each system needs to generate and transmit data is of critical importance to the smooth operation of the rail system—smooth operation itself requiring further time.

*Time measurement*: The nature of the method of time measurement can directly influence the accuracy and reliability of location data. For example, if the GPS signal's timing is off, it could result in inaccurate location data. Similarly, the time taken by a train to pass a particular point influences the data produced by mechanical devices. This underlines the importance of maintaining accurate and synchronized time measurements across different systems to ensure the integrity of the location data. Moreover, different ways of measuring the time when a train passes a particular point shape the decision-making process. For example, if the GPS does not work, the knowledge about times is coarser due to the fact that other devices give time information less frequently. More reasoning is required to estimate the movements of trains in such situations. Relying solely on GPS for modeling rail traffic is fraught with complications, given the influence of numerous integral safety and control systems on train operations. Safety mechanisms like signals and track circuits, as well as control elements like automated train systems and speed governors, significantly impact traffic flow. While GPS can accurately provide spatial data, it does not account for the dynamic factors and real-time changes that these systems introduce. Consequently, for an accurate representation of railway traffic, the system needs to incorporate data from multiple sources rather than relying exclusively on GPS.

*Representations of time*: Different systems in the rail operation represent time in their own unique ways. GPS data are delivered in real-time, whereas mechanical devices relay data only when a train passes a certain point. These different representations of time can cause complications, especially when the data from these systems need to be integrated. The multiplicity of time and location data also highlights the importance of understanding different time representations. It is important for operators and users to understand these differences to ensure the smooth functioning of the rail system and make informed decisions based on the available data.

In Finnish train traffic, time representation can take different forms. For humans, time is largely perceived through personal actions and their subsequent results. This perception is uniquely individual, leading to a range of behaviors. For instance, some people are always punctual, some are perpetually late, while others exhibit varied patterns. As such, human time is unpredictable and not easily quantified. In the realm of information systems, time is more

structured. These systems rely on the fundamental units of time as defined by physics, such as seconds, minutes, and hours. This represents logical time. However, modern artificial intelligence algorithms have the capacity to manipulate time through tens of thousands of different variables, creating a dynamic range between order and chaos in time representation. This means that, in information systems, time can either be logical, chaotic, or a mix of both. The third significant dimension of time, especially relevant to train traffic in Finland, is the time of nature. Nature operates on its own temporal scale, which we primarily understand through the laws of nature and physics. Natural phenomena like sudden frosts, storms, floods, and earthquakes occur unpredictably, following their own rhythm or flow.

Interestingly, passengers can view train information on their mobile phones, but VR Group does not have access to passenger information. This means that VR and their systems lack information about the movement of passengers. For example, if a passenger leaves the train before reaching the station, no one is aware of this occurrence. If the aim is to enhance the passenger experience, it is crucial to track the passenger's location and time requirements. Instead of a barrier fence between the operations center and passenger traffic, there should be a symbiotic relationship.

*Processing measurements and representations of time in decision-making and planning*: Precise location data, provided by GPS or mechanical devices, plays a critical role in decision-making, planning, and system operations. For example, in the case of a delay, real-time location data from GPS can allow the operational center to request the driver to accelerate to compensate for lost time. Inaccuracies or delays in this information can significantly impact operational decisions which leads to further disruptions. The importance of time measurements in these processes highlights the need for accurate and timely data. Moreover, although customers can choose where to travel, railway operators alone set the time schedule. The permission to start the train is granted based on the systems managed by Fintrail, including safety and control devices. The start and stop times of bypass points for trains are defined using software technology that utilizes an advanced automation control system. Each station in Finland has its own system, which makes overall control challenging. Train accidents are rare occurrences due to the automation systems, as they prevent the train from departing if the track is not clear. These situations are indicated by clear red graphic markings in the programs.

*Coordinating timed actions, events, and processes*: The coordination of trains on the tracks requires accurate location data and effective timing. The rail operation must coordinate the timing of each train to prevent conflicts, or even accidents, and maintain smooth operations. For example, if GPS data are lost, mechanical devices provide the backup data, but they do this with some delay. Moreover, the delay time is dependent on the speed of the train. This emphasizes the importance of timing in coordinating actions and processes. How the system works affects the ability to time, and the ability to time is reflected back on how the system is guided. The timing aspect of *time-need* is thus critical to ensure safety and efficiency in rail operations. In Finnish train traffic, there are over 7000 malfunction situations per year. The Finnish management information systems (MIS) can send instructions to the driver's terminal, indicating when to speed up or slow down. In the future, predictive information management systems will ensure that trains do not remain at meeting places for too long.

*Controlling time management and representations*: In the case of the rail operations, controlling the use of time can manifest in several ways. For example, based on the GPS location data, the operational center can attempt to control the speed of the train to maintain schedules. Similarly, the control center can also influence how passengers receive information about delays or malfunctions by controlling when and how such information is shared (e.g., via social media or digital signs at stations). The control-aspect of *time-need* underlines the importance of managing and coordinating the use of time across different agents in the system, from mechanical devices to human operators to passengers. Trains and other mechanical devices are becoming increasingly intelligent, with the ability to alter information while receiving training to become self-steering. Intelligent management information systems (MIS) that use genetic algorithms to operate and modify time currently exist. This is significant because it shows how nonhuman actors, such as trains, can manipulate information over time, rather than relying solely on human actors.

## 5 | LESSONS FROM THE RAILWAY CASE STUDY FOR FUTURES RESEARCH

The case discussed above provides several general insights on time and temporality, especially from the perspective of the issues discussed in Section 2. In this section, we discuss the insights.

First, the case study about railway transportation offers a complex, real-world example of time and temporality as elements in future-oriented thinking and planning. GPS and mechanical tracking devices provide continuous and discrete location data and this shows concretely that temporality can take on diverse forms in operational settings. For example, the GPS information represents a continuous flow of time and gives an uninterrupted sequence of train location data. In contrast, mechanical tracking devices provide a more fragmented measurement of time by giving information at specific moments when the train passes certain points. While the data provided by different systems can be projected on a linear timeline, their main function is not to produce such unified representation. Rather, they make it possible, in their unique ways, to coordinate various operational activities, react to disruptions, and engage in future-oriented planning. These differences, not some imagined projection on an abstract linear timeline, enable the smooth running of the railway transportation system across different types of situations that involve different problems. Future-oriented actions, such as adjusting train schedules or predicting arrival times, heavily rely on the integration of multiple sources of temporal information and the inferences that the sources allow. Thus, different

temporalities within a single system can shape the future outcomes of that system in concrete and significant ways, depending on the specific circumstances and requirements.

Second, the case study points to potential difficulties stemming from different conceptions and uses of time. The GPS and mechanical tracking systems represent time in different ways (continuous vs. discrete) and these differences can lead to complications when one attempts to integrate the information that these systems provide. The linear and unidirectional conception of time can be trivially posited on the background of these systems, but, in reality, the systems are used differently due to their different temporalities. In fact, the idea that the temporalities should or could be unified may distract us from understanding their operational mechanics and use in different situations. This, in itself, provides a cautionary note. The unique temporalities within systems can contribute to their functionality and robustness. Different conceptions of time are not confined to different contexts. They can coexist without a forced integration to a single unified representation.

Third, the power dynamics and control mechanisms that underlie the management of time become visible in the railway transportation case study. The operational center, armed with real-time location data, can make authoritative decisions, such as adjusting the speed of a train to ensure the maintenance of the schedule. This control of time and knowledge of time, operationalized through technology, shapes not only the movement of the trains but also the overall efficiency and reliability of the rail system and creates the possibility space of action to other actors. Moreover, control is not limited to managing the immediate operational aspects of time but also extends to controlling the flow of information about delays or malfunctions to passengers. Thus, the management of time and associated decision-making reveal how power, authority, and control are inherent in temporal considerations.

Fourth, the railway case study demonstrates the relationship between temporality, background knowledge, and the interpretation of temporal data. Real-time GPS data provides a continuous flow of information about the train's position, but its usefulness depends on the interpreter's understanding of the railway system. On the other hand, mechanical devices offer discrete, moment-specific data, providing reliable insights into the train's location. Each data point serves as a snapshot and requires specialized knowledge for interpretation. Additionally, passengers are primarily concerned with the arrival time of their train. A deeper understanding of railway systems could influence how they perceive time. These different forms of temporal data and the associated knowledge that filter its interpretations illustrate the significance of background knowledge in shaping the interpretation and utilization of information and beliefs about time. Different temporalities carry associated layers of knowledge that enable to make sense of those temporalities.

Fifth, the case study exemplifies the recognition of plurality in temporalities concretely through the operation of GPS and mechanical tracking devices. These systems coexist with their own distinct temporal rhythms: continuous for GPS and event-based for mechanical devices. This plurality is not merely an operational detail but deeply shapes actions and decisions within the railway system. Successful management and planning of railway operations requires understanding and integrating these diverse temporalities. The case study shows the need for a nuanced understanding of time to efficiently coordinate actions and processes— and, crucially, to understand what "efficiency" means for different actors. Moreover, the plurality of temporalities extends beyond technical aspects and encompasses the temporal experiences and orientations of operators and passengers. Different groups may have varying temporal perspectives and priorities which can lead to conflicts in aligning their temporal orientations. Understanding the diverse temporal perspectives of individuals and groups, as well as the broader social and cultural contexts shaping their conceptions of time, becomes central to the thinking about the whole techno-social system of railway traffic. Without this understanding, optimal handling of operations is not possible.

## 6 | THE TIME-NEEDS IN FUTURES RESEARCH

We have now seen how the case study illustrates certain insights that has been achieved in futures research with respect to time (see Section 2). In this section, we take a bit more normative tone and suggest some further elaborations on the basis of the discussion thus far. We discuss three central tenets of futures research on the basis of the analysis of time provided in this paper. These central tenets are (i) study of possible and desirable futures, (ii) study of knowledge and assumptions about the future, and (iii) reflections on power and control over the future.

First, incorporating the notion of *time-need* into futures research sheds new light on to the thinking about the possible and desirable futures. It brings a perspective on the various roles that temporality plays in shaping our ideas about what is feasible and preferable in the future. As Bussey puts it "Futurists work with time, yet we rarely consider the full implications of what this means. It could equally be said that futurists work within time, navigating the cultures and ecologies of time that shape the worlds they seek to enable" (Bussey, 2017, 236). The notion of *time-need* makes these cultures and ecologies of time visible. *Time-need* explicates to us that different actors carry unique temporal requirements based on their roles, responsibilities, and desires. For example, in the case of train traffic, a policy-maker may prioritize a long-term, strategic vision of the future, while an operator might focus more on immediate, operational details. These diverging time-needs can carry different views of what futures are considered possible or desirable. Interestingly, it has been noted, in the case of railroad traffic, how different contexts shape time-needs and the associated criteria of desirability: "In low-frequency networks, passengers perceive on-time performance to be the most important service characteristic [--] However, in high-frequency networks, regularity (i.e., the ability to keep equal headways between trains) is perceived as more important" (Parbo et al., 2016, 501).

Moreover, considering *time-need* allows us to anticipate how temporalities may transform in the future. For example, technological advancements can introduce new time scales and alter time-needs. A historical example is the evolution of communication methods, from slow letter exchanges to instantaneous global connectivity through the internet. This highlights the intimate relationship between time-need and technological progress. Additionally, socio-cultural shifts can introduce new rhythms and routines into people's lives, influencing their time-needs (Anttila & Oinas, 2018). Understanding these potential changes in time-needs enables us to develop future scenarios that are more nuanced and aligned with the realities of the actors involved. Time-need and socio-technological context mold each other rather directly.

Moreover, the consideration of *time-need* can guide us to make possible futures more accessible cognitively. It forces us to consider not just the "*what*" of the future, but also the "*when*" and "*how*." Understanding when potential changes might transpire and how different systems, stakeholders, and sectors might need to coordinate their actions in time is beneficial to creating future scenarios that are pragmatic and have a higher plausibility. For example, transitioning to renewable energy requires anticipating various changes and coordinating diverse sectors like energy, automotive, government, finance, and the public. In a recent study, Hirsch (2020) has discussed how Scotland's strategic approach to renewable energy transition successfully unified the various rhythms and temporalities of different stakeholders. By setting clear goals, stimulating sector-wide innovation, endorsing community-owned energy systems, and employing creative governance strategies, Scotland was able to orchestrate a coordinated and rapid transition towards renewable energy. This means that understanding the relevant the timing of potential changes is necessary for successful coordination and transition. Recognizing the diverse time-needs of various actors is needed for the successful orchestration and timing. By incorporating and considering these different time-needs in futures research, we can improve our understanding and practice of exploring future possibilities in a more comprehensive and inclusive way.

Second, time is not a mere background. Rather, it is measured, represented, and known (or unknown). How it is measured and represented depends on available resources and needs. However, the measurements and representations also determine what can be done. How we represent and think about time affects how we attempt to create knowledge of the future. At the same time, approaches to know time—the *when* of something—is shaped by how we approach the future. To give an example of this two-directional dynamic between time and knowledge, compare forecasting and scenario planning. Forecasting can be used to give estimates of what happens in well-specified timeframes but is ridden with uncertainty. On the other hand, scenario analysis does not deal with equally specific timeframes and therefore it provides a solution to uncertainties at the cost of specificity. (O'Mahony et al., 2023.) The chosen orientation towards time creates the possibility space for what kind of knowledge can be created. To analyze how knowledge about future is produced, futures research needs to pay further attention to measurement, representation, and processing of time and temporal information.

Each actor within a system has their own unique way of processing and making sense of temporal information, which is largely shaped by their specific time-needs. For instance, policy-makers rely on relatively long-term forecasts and trends to inform their decisions, focusing on understanding larger temporal patterns. On the other hand, train dispatchers heavily rely on short-term forecasts and immediate operational data to make quick decisions in response to immediate circumstances. These distinct time-needs can lead to conflicting interpretations and assumptions about the future. For example, a long-term forecast of increasing passenger numbers might be seen as a positive trend by a policy-maker and lead them to advocate for increased infrastructure investment. However, a train dispatcher may perceive this as a potential strain on current operations and prioritize maintaining current service levels. Without recognizing and addressing these differing time-needs, differing interpretations among actors could result in confusion, disagreement, or even conflict. How individuals conceive and respond to futures is not solely influenced by time but also by their understanding and utilization of time, that is, their time-needs.

The notion of *time-need* is a useful tool to understand how people understand and know things differently through their relation to time. How to measure, represent, and process information about time depends on the situation. How people can know the future and act toward it depend on their means to measure, represent, and process time. As Valkenbur puts it “Many things we know, we know in a particular time or timeframe” (2022, 442). However, also people's goals and plans shape how they measure, represent, and process time. What questions we ask about time and durations depends on our goals. For example, a recent study on the experiences of early career academics distinguishes between short-term, institutionally imposed tasks, and long-term, personally significant research tasks. The former prompts questions about time management, meeting deadlines, and completing tasks efficiently, while the latter raises questions about the timeline for achieving research goals, planning for sustained research productivity, and envisioning an academic future (Osbaldiston et al., 2019). What should be done, how it should be done, and how much should be done depend on the type of timeframes that actors find necessary or meaningful.

Third, the notion of *time-need* allows us to view how actors with differing temporal perspectives can control each other's futures. *Time-need*, which defines an actor's temporal requirements for planning, coordinating, and decision-making, plays a significant role in shaping power dynamics within a system. Power and control are topics that are discussed especially in critical futures studies (Inayatullah, 1998; Slaughter, 2004). Critical futures studies emphasize the socially constructed nature of the future and aim to challenge existing power structures. Similarly, the notion of *time-need* directs our attention to the diverse ways different actors experience and interact with time based on their roles, responsibilities, and desires. It forces us to consider how temporal power dynamics, such as control over the pace, rhythm, and timing of events, can shape our potential

futures. By recognizing and addressing these power dynamics, we can work towards more inclusive futures that consider the diverse time-needs of all actors. Additionally, *time-need* sheds light on mechanisms of coercive action, as temporal phenomena are intimately connected to the exercise of power.

Different actors may try to exert control over the temporal representations and measurements to match their own objectives and goals, and this can lead to conflicts. For example, an operational center might want real-time data for immediate decision-making, while maintenance crews might be more interested in longer-term data trends for planning maintenance schedules. Moreover, it has been noted in the literature that "A discrepancy exists between how train-oriented railway operations are planned with the main focus being on the trains and how passengers actually perceive and respond to railway performances" (Parbo et al., 2016, 501). As Wagner and Matuszek have argued, differences in temporalities "shape the relations between expectations, decisions and observations of these decisions" (2022, 11). However, the power to control time-needs has the potential to do great harm. In the most extreme cases, the failure to synchronize one's time-need to that of the hegemonic system may lead to a situation where people do not have "the means to strategically position them in the discourse and, thereby, contribute to [the] realization" of visions of the future and, therefore, they do "not have a future" (Sand, 2019, 99). This leads to inequalities in future-making. For example, task-oriented temporalities were marginalized by clock-time industries. From the marginalized position, it is extremely difficult to take a stand on the future, as the discourse is shaped by the industries and proceeds in terms associated with their time-needs.

The control over time extends to the distribution and withholding of temporal information. A control center, for example, can choose to share or withhold information about delays, disruptions, or rescheduling based on its operational needs and priorities. This type of control has implications not only for actors' perception of the present but also for their anticipation and planning for the future. Consider a mining company that anticipates a rapid increase in mineral demand in the coming decades based on proprietary research. However, it keeps this information and especially the expected timelines confidential and thus limits broader societal engagement on resource management and environmental sustainability. Simultaneously, a government agency operates on a shorter timescale with its own forecasts, unaware of the future demand increase. This example illustrates how controlled distribution of future-oriented knowledge can shape perceptions, impact future anticipations, and influence long-term processes.

We can see that acknowledging *time-need* can provide a novel perspective on the dynamics of power and control in futures research. It brings attention to how temporal needs can be manipulated to gain control, how power can be exerted through the control of temporal information, and how differing time-needs can lead to conflicts. This understanding can enhance our critical reflection on power relations in future-oriented systems and operations.

## 7 | TIME-NEEDS OF THE FUTURES RESEARCH ITSELF

We wish to point out that *futures research as a field has its own time-needs*. Let us explain.

In futures research, we often need a nuanced understanding of multiple temporalities and the ability to navigate them adequately. The discipline involves not just exploring the immediate and short-term future but also envisioning scenarios that span decades. It requires moving away from linearity and embracing the complexities and contingencies inherent in various temporal scales. Just as in the railway case, where the systems operate across multiple temporal scales, futures research also needs to function effectively across different timescales. This requires reflection on how the timescales are related to other aspects of research. For example, it has recently been noted how economic foresight in public policy encompasses two distinct approaches: short-term economic forecasts and long-term economic scenarios. These approaches differ not only in their timescales but also in their relation to uncertainty: "Rather than seeking to predict or forecast outcomes (which is ridden with event-driven uncertainty, in addition to ever-present systemic uncertainty in economies), scenario analysis seeks to embrace uncertainty by exploring a plausible or possible range and by encouraging more robust decision-making under uncertainty" (O'Mahony et al., 2023). What we can do, and what we therefore wish to do, in research affects how we conceive relevant timescales and how we approach them. Understanding and managing the different aspects of *time-need* of futures research are crucial for maintaining the relevance and flexibility of the field.

Additionally, the tools and techniques used in futures research, such as scenario planning, trend extrapolation, and Delphi surveys, each have their own time-need. They require certain amounts of time and specific representations of time to work as intended. For example, scenario planning involves creating detailed and plausible views of how the future could unfold. This method typically operates on a longer timescale, often looking decades into the future. Scenario planning typically involves a significant amount of time to carry out as it requires extensive research, analysis, and sometimes stakeholder engagement (Chermack, 2011). On the other hand, trend extrapolation is a more straightforward method that does not require equal amount of time (e.g., Chapin, 2011). Analysis of trends is also associated with shorter timescales—except when the discussion is about megatrends. This is interesting. While trends require us to respond promptly to more immediate changes, megatrends demand that we anticipate and adapt to large-scale. Both are important for futures research, but they necessitate different types of temporal attentiveness and actions (Slaughter, 1993). We see that temporal scales, topics, methods, and goals are tied together. Thus, the field of futures research must be able maneuver between different time representations and it must do this with awareness.

Taking into account the time-need in futures research also highlights the importance of adequate time resources. Sufficient time allows for more thorough research, deeper reflection, and more comprehensive engagement with stakeholders. Yet, time constraints are often a challenge in futures research, with demands for rather immediate solutions or insights. Moreover, the processes of scenario work can be such that they

are, due to their very nature and execution, in conflict with other time-needs. For example, it has been suggested that climate change scenarios "have relied on research processes that slowed the exchange of information among physical, biological and social scientists" (Moss et al., 2010, 747) and this affects the ability to deal with climate change. Research processes, exchange of information, and the battle against climate change are all temporal phenomena, and in this case the nature of one of the phenomena—research— affects the timing of others. Recognizing this aspect of *time-need* can help in better planning and management of future-oriented research projects.

The time-needs of futures research itself can perhaps be better understood if we analyze them in terms of the levels of Causal Layered Analysis (CLA).[4] CLA offers a conceptual tool through which to explore the complex interplay between time, temporality and futures research. This analytical framework focuses on four distinct layers—litany, systems, worldviews, and myths. As we go through these layers, we can better perceive the depth of the issues related to the notion of *time-need*.

The method of CLA "is concerned less with predicting a particular future and more with opening up the present and past to create alternative futures" (Inayatullah, 1998, p. 815). It is a "method that reveals deep worldview commitments behind surface phenomena" (Inayatullah, 1998, p. 815.). CLA consists of analysis in/of four levels:

"The first level is the 'litany'—quantitative trends, problems, often exaggerated, often used for political purposes. [–]

The second level is concerned with social causes, including economic, cultural, political and historical factors. [–]

The third deeper level is concerned with structure and the discourse/worldview that supports and legitimates it. [–] The task is to find deeper social, linguistic, cultural structures that are actor-invariant [–]. Discerning deeper assumptions behind the issue is crucial here as are efforts to revision the problem. [–]

The fourth layer of analysis is at the level of metaphor or myth. These are the deep stories, the collective archetypes, the unconscious dimensions of the problem or the paradox. [–] This level provides a gut/emotional level experience to the worldview under inquiry. The language used is less specific, more concerned with evoking visual images, with touching the heart instead of reading the head." (Inayatullah, 1998, p. 820).

There are rich layers in how and why futures research is built on certain time-needs. In the analysis, we rely on the arguments presented in this and the sections throughout the paper.

*The litany* of futures research, when it comes to time-needs, often centers on time-related challenges. In the field, there is often a tension between the push for immediate results and the need to explore rich long-term scenarios with more resources. Linear thinking is viewed as outdated, and the need to understand the complexities of the future are repeatedly pointed out. Relatedly, the distinction between short-term forecasts and long-term scenarios is a common point of discussion. Tools like scenario planning demand significant time and are contrasted with quicker methods like trend extrapolation. The importance of there being enough time for thorough research is emphasized but practical constraints often lead to shorter research projects. The pace of research, especially in collaborative efforts, is seen as crucial but also sometimes problematic. In essence, the litany highlights the temporal challenges in futures research that affect the researcher's ability to access resources that are needed to achieve adequate results.

*The systems level* of futures research, when it comes to time-needs, connects to the broader structures influencing the field. Economic and political systems often create a sense of urgency and need for short-term outcomes and immediate insights from futures research. The rapid evolution of research institutions intensifies these demands and set a fast-paced rhythm for researchers. Constrains in resources further shape the environment where research is performed and impact how projects are planned and executed. These systemic drivers do not only dictate the pace but also influence what the methodologies chosen. Sometimes quicker, more immediate approaches are favored over in-depth, long-term studies. In essence, the systems level points the external pressures and larger frameworks that shape the direction and tempo of futures research.

At *the worldview level*, futures research is based on the belief that the future is uncertain and our decisions today shape tomorrow. This perspective grounds the need to explore several temporalities that range from immediate outcomes to long-term scenarios. The field recognizes that while we can map out various possible futures, our most desired outcomes, like actions against climate change, might remain unachievable, at least in the relevant timeframes. This understanding of time is not just about difficulties in knowing the future but also about accountability and humility in the face of the vast temporal landscape. The emphasis is on both understanding the complex web of causality that might unfold over time and challenging conventional short-term thinking (Wright et al., 2013). In sum, the worldview points the intimate relationship between the temporal challenges and the deeper philosophical underpinnings of futures research.

In the *mythic level* of futures research, the traditional prevailing narrative is about the linear progression of time that is anchored in Western modernity that penetrates all thinking in the culture, including academic fields that have history embedded in this culture. In this view, the future is a sequence of novel events that are each caused by its predecessor. The sequence suggests that events are products of inevitable trajectories. However, this linear interpretation faces increasing skepticism and scrutiny. Many critical futures researchers now believe that such a narrow perspective may restrict our imaginative scope and hinder broader visions of possible futures. They point out that our understanding of time is not universal but, rather, it is shaped by diverse cultural, societal, and even gender-based influences. For example, while the Industrial Age's focus on strict time management was groundbreaking, it may not align with today's challenges. A segment within futures research is advocating for a reevaluation and broadening of our time-related myths—including this paper. Some propose a departure from the linear paradigm by contending that it may not resonate with the nature of our times. Drawing from feminist and non-western viewpoints, some suggest a more diverse and encompassing narrative of time. Fundamentally, at the mythic level, the emphasis is on the powerful role of the narratives we craft about time. These narratives, whether they lean towards continuity or transformation, profoundly

shape our hopes, plans, and feelings about what lies ahead. This cannot be without impact on futures research works in practice.

To sum up, our discussion points to the realization that futures research—much like the railway transportation system—is deeply embedded in the dynamics of time. Its multiple time-needs shape the way it approaches the study of the future. Moreover, the time-needs of the field cannot simply be listed, as they have nested complexity that can be revealed through a framework like CLA. Acknowledging these time-needs can inform more sophisticated, context-sensitive approaches in futures research and improve the quality of its contributions to society's understanding of and preparedness for future scenarios.

## 8 | ASSESSING AND MANAGING TIME-NEEDS FOR FORESIGHT INTERVENTIONS

We have now seen how important time and temporality are within futures research. To help futures practitioners to better understand how relevant these are at the level of research projects, we now describe a structured process and associated checklist that takes into account the actors/organization's current time-related practices, goals, and stakeholder needs when a foresight intervention and an associated futures research project is conducted.

Step 1: Identify the organization's time-needs.

1.1 Time required for processes and actions
- Determine the duration needed for key tasks and activities
- Consider personal preferences, resources, technology, and societal expectations that determine the time required

1.2 Time measurement
- Assess the organization's current time-measuring tools and systems
- Identify the required precision for different tasks and contexts

1.3 Time representation
- Evaluate how time is represented across various actors and systems
- Consider the impact of time representations on system functionality and human/non-human interaction

1.4 Time processing in decision-making, planning, and operations
- Analyze how time measurements and representations are incorporated into processes
- Assess the impact of temporal information on predictions, analysis, and task execution

1.5 Coordination of timed actions, events, and processes
- Examine how actions and events are timed within the organization
- Identify the level of precision required for successful coordination

1.6 Control over time management and representations
- Assess how different actors influence the use, representation, and processing of time
- Consider the power dynamics and potential conflicts arising from time control

For example, in the case of a railway system, identifying the organization's time-needs involves considering factors such as the time required for trains to travel between stations, the precision and reliability of GPS and mechanical tracking devices, how temporal information is represented to passengers and staff, and how real-time location data is used to manage delays and optimize network performance. We discussed these in our case above.

Step 2: Evaluate the intervention's time-needs

2.1. Determine the temporal requirements for the intervention's goals and objectives
- Go through the list in Step 1 with regard to the intervention itself
- Reflect on the on how the temporal scales, topics, methods, and goals of futures research are interconnected and shape the approach to studying the future (see the previous section).

2.2. Assess the compatibility of the intervention's time-needs with the organization's existing time-needs
- Evaluate if the intervention's temporal requirements align with the timing and phase of current organizational practices
- Identify any potential conflicts or mismatches in aspects of time-needs—such as required process durations, measurement precision, information representation, data use in decision-making, action coordination, and control over timing—can lead to tensions, communication issues, and workflow disruptions in their collaborations.
- Differences in how organizations cognize, structure, and manage time can lead to friction in their collaborations as well as imbalances in control over time.

2.3. Identify potential temporal conflicts or misalignments among stakeholders
- Assess if different stakeholders have conflicting priorities or expectations around timing
- Check for misalignment between the intervention's time-needs and stakeholder preferences for measuring, representing, and processing

For example, in the context of a railway system, evaluating the intervention's time-needs would involve assessing the temporal requirements and constraints of both the proposed intervention and the existing railway system. This would include analyzing the compatibility between the intervention's temporal requirements and the organization's existing time-related practices, addressing potential mismatches in aspects such as required process durations, measurement precision, information representation, data use in decision-making, action coordination, and control over timing. For example, the intervention might require fixing specific dates for the work whereas the railway system may face unexpected challenges that draw the resources on those days. Evaluating the time-need of the intervention would also involve analyzing possible temporal conflicts or misalignments among stakeholders, such as passengers' desire for punctuality versus the rail operator's focus on network efficiency, and checking for misalignments between the intervention's time-needs and

stakeholder preferences for measuring, representing, and processing temporal information.

Step 3: Develop strategies to manage and align time-needs

3.1. Establish a shared understanding of time measurements, representations, and processing across the organization
- Ensure consistent definitions and representations of temporal concepts
- Align visual displays and formats for communicating timing information

3.2. Create mechanisms for coordinating timed actions, events, and processes
- Implement systems and processes to synchronize timing across the organization
- Build in feedback loops to re-coordinate timing when disruptions occur

3.3. Address power dynamics and potential conflicts related to time control
- Provide transparency around who controls timing decisions and processes
- Establish governed ways to resolve conflicts over timing and measuring priorities

3.4. Align the intervention's time-needs with the organization's goals and objectives
- Clearly link the intervention's timing requirements to higher-level organizational objectives
- Modify timing needs if misaligned with core goals like safety, efficiency, and so on.

For example, in the context of a railway system, to conduct a foresight intervention, one needs to establish a shared understanding of time measurements and representations across the organization. This can be achieved by ensuring that temporal concepts, such as 10-year time horizons, are consistently defined and aligned with the existing planning cycles. In addition, coordinating the timing of foresight activities with ongoing operations is crucial. This includes implementing clear rescheduling processes to handle disruptions. Providing transparency on timing decisions and establishing ways to balance stakeholder needs when scheduling foresight work are also important steps that help address power dynamics and potential conflicts. Finally, the foresight process's timing requirements should be linked to the railway's overall strategic objectives. If necessary, these requirements should be modified to ensure that the process remains relevant and valuable.

By using this checklist and diagnostic approach, futures practitioners can systematically assess an organization's time-needs, evaluate the temporal requirements of a planned intervention, develop strategies to manage and align time-needs, and effectively implement and monitor these strategies. This conceptualization of the relevant considerations enables practitioners to design and execute futures/foresight interventions that are more relevant, effective, and compatible with the organization's temporal realities, ultimately leading to better outcomes and more sustainable long-term success.

## 9 | CONCLUSION

In this paper, we introduced the notion of *time-need* to futures research and suggests that the temporal dimensions of futures research deserve more nuanced understanding and application. By analyzing how different aspects of people's relation to time can shape their interactions and negotiations of the future, the paper suggests novel ways of engaging with temporality in futures research. Even in paradigmatic contexts of clock-time, such as railroad traffic, time is anything but simple and transparent issue.

Transposing these insights onto the field of futures research itself, we recognized that the discipline operates with various time-needs. Each methodological approach in futures research (and their intended impacts) carries with it a unique time-need and engagement with temporality. Recognizing these different aspects of time-need is important to generate more reflective approaches to futures research. The notion of *time-need* pushes the boundaries of how we understand and problematize time in futures research. It invites us to engage more deeply with the temporal dynamics that shape our anticipations of, and engagements with, the future. Understanding, acknowledging, and managing our time-needs can open up novel avenues to understand possible and desirable futures.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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## ENDNOTES

[1] By "western modernity" we refer to what has been perceived as historical period and cultural transformation from the late 17th century through the present that emphasizes rationality, individualism, democracy, capitalism, secularism, and scientific advancements. It has been perceived as a transition from traditional values to a focus on human reason, progress, and individual achievement, shaping global politics, economics, and culture. We are not committed to the idea that the positive attributes of "the liberal-progressive narrative" (see Gregory, 2016) characterize the period adequately. Our focus is merely on the conceptions of time associated with the period and their influence on the present world.

[2] In nonhuman systems, such as artificial intelligence and automation, understanding the impact of time constraints and variations can lead to more efficient system designs and better overall performance. In the future, artificial intelligence could be instrumental in enhancing our understanding of relational time (see below). In transport, the system comprises tens of thousands of distinct variables. Variables stemming from outside the system are currently beyond the control. For instance, predictive models for weather fluctuations are based on Random Forest artificial intelligence models. Integrating these models into logistic systems could represent a significant step towards safer and more efficient train traffic.

[3] Empirical information was gathered between 2018 and 2019. Business Finland funded the study project, and several scholars from various fields, including ICT and service design, participated in it.

[4] See also Virmajoki (2022) discussing CLA in relation to futures of science in general.

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