



Geographia Polonica

2026, Volume 99, Issue 3, pp. 379-392

<https://doi.org/10.7163/GPol.0332>



INSTITUTE OF GEOGRAPHY AND SPATIAL ORGANIZATION
POLISH ACADEMY OF SCIENCES
www.igipz.pan.pl

www.geographiapolonica.pl

RECONCEPTUALISING PACEMAKERS AS RELATIONAL AND TEMPORALLY VARIABLE ENTITIES: EVIDENCE FROM THE MOBILITY OF WORKING STUDENTS

David Gorný 

Department of Geography
Masaryk University
Kotlářská 2, 602 00 Brno-střed Brno: Czech Republic
e-mail: gorny.david@mail.muni.cz (corresponding author)

Abstract

Working students provide a useful case for extending the conceptual understanding of pacemakers, as their everyday mobility emerges through the coordination of university and paid work schedules. This paper reconceptualises pacemakers as dynamic and relational entities whose organising influence fluctuates across different temporal phases. Rather than treating pacemakers as stable sources of rhythm, the analysis demonstrates that they generate multiple heterogeneous rhythms with uneven organising capacities. The findings reveal distinct rhythmic mobility configurations and substantial variation in commuting behaviour across the academic year. The paper thus contributes a new perspective to rhythmanalytical and mobility-oriented research on everyday temporal organisation.

Keywords

pacemaker • rhythm • rhythmanalysis • temporal regimes • time-geography • student mobility • working students • commuting • everyday life

Introduction

Everyday mobility can be understood as a rhythmic phenomenon that shapes the organisation of daily life. Such rhythms emerge through recurring but continually changing patterns of movement organised across time and space. They comprise both regular and irregular movements of people, vehicles, and other elements that together form the dynamic fabric of the urban environment.

Mobility rhythms are not produced randomly but are organised through institutional schedules, social norms, and everyday routines. Commuting, in particular, represents a highly rhythmic form of mobility structured through working hours, university timetables, deadlines, and other temporal frameworks that regulate everyday movement across urban space. In this sense, patterns of mobility are closely connected to how everyday life is organised in time (Edensor, 2011).

These institutional rhythms become particularly visible in the case of working students, whose everyday mobility is structured by the interaction between university and work schedules. In the Czech Republic, recent EUROSTUDENT VIII (2025) data indicate that around 70% of students work either regularly or occasionally during the lecture period, considerably above the EU average of 59%. The coordination of work and study, therefore, represents an increasingly common feature of students' everyday lives and, consequently, of their everyday mobility. Student employment differs from that of other commuting populations. By combining study and paid work, students must synchronise two institutionally imposed temporal regimes, each of which independently structures everyday life. University obligations, lecture schedules, seminar timetables, assignment deadlines, and examination dates play a central role in organising daily routines, as universities impose relatively strict temporal structures that constrain the degree to which students can manage their own time (Liao et al., 2013; Camargo et al., 2020; Chim et al., 2020), while employment introduces additional temporal demands associated with working schedules and the coordination of competing temporal regimes (see Kotýnková Krotká & Porkertová, 2026). In balancing these demands, students must integrate two institutional regimes that would normally constitute separate dominant spheres of everyday life. Working students thus provide a particularly useful analytical case for examining how pacemakers interact, compete, and reorganise everyday mobility across different temporal phases.

University students have become the focus of research across a wide range of themes and disciplinary perspectives. Existing studies have examined work-study balance, academic performance, time use, well-being (Curtis & Shani, 2002; Hall, 2010; Pusztai & Kocsis, 2019), mobility behaviour, and commuting practices (Szmelter-Jarosz & Suchanek, 2021; Rodríguez-Rad et al., 2023). Within mobility research, attention has focused on commuting experiences,

embodied mobility practices, and belonging among commuting students (Holton & Finn, 2018, 2020; Prazeres, 2018; Wilkinson & Badwan, 2021; Stalmirska & Mellon, 2022), while quantitative studies have examined students' daily mobility patterns, commuting flows, and travel behaviour across different socio-economic contexts (Kraft et al., 2020, 2025; Cadima et al., 2020). These studies provide important insights into students' mobility behaviour and the present paper builds on this research background. Although the paper contributes to existing research on students' mobility, particularly among students combining study and paid work, its primary aim is to understand how institutional temporal regimes rhythmise everyday life and mobility, with particular emphasis on the role of pacemakers, which this case allows us to reconceptualise. Drawing on cluster analysis and chi-square tests of questionnaire data, the study identifies distinct rhythmic mobility configurations and develops a broader conceptual understanding of pacemakers in everyday mobility. The paper thus contributes primarily to rhythm-analytical and mobility-oriented discussions on the temporal organisation of everyday life.

The paper's analytical structure proceeds in three steps. Following the theoretical discussion expanding the conceptual understanding of pacemakers and the methodological section, Section 4.1 examines the relationship between dominant pacemakers and employment arrangements. Section 4.2 analyses changes in commuting frequencies across lecture, examination, and holiday periods using cluster analysis. Finally, Section 5 develops a broader conceptual interpretation of pacemakers and discusses their heterogeneous, temporal, and relational characteristics within everyday mobility.

Literature

Towards a definition of pacemakers

To understand the emergence of pacemakers as the central concept of this paper, it is necessary to begin with broader discussions

within time geography and rhythm analysis concerning the temporal organisation of everyday life. Much of the contemporary understanding of rhythm in mobility research draws on Henri Lefebvre's work. For Lefebvre (2013), rhythm emerges through the interaction of time, space, and energy, producing recurring patterns of movement that organise everyday life. Rhythm is, within this perspective, fundamentally grounded in repetition. As Lefebvre (2013: 6) notes, "*there is no rhythm without repetition in time and in space.*" Yet, as Lefebvre (2013) argues, repetition is never absolute, since each recurrence introduces subtle variations that shape our perception of time and space. Similarly, Amin and Thrift (2002) emphasise that rhythms are multiple, overlapping, and continuously renewed through recurring practices and movements. Rhythms therefore differ in their frequency, intensity, duration, and temporal coordination. Within mobility studies, rhythm is thus understood as a form of repetitive movement in time and space that possesses a measurable structure while simultaneously encompassing variability and change. The sources through which rhythms become temporally regulated are conceptualised in Hägerstrand's (1982) notion of pace-setters. He likens these *pace-setters* to a metronome whose steady ticking sets the tempo, drawing parallels between the church bell, the factory clock, and the metronome itself. In this vein, Parkes and Thrift (1975) use the term '*pacemakers*' to refer to points in time and space that serve as sources of timing. From a slightly different perspective, rhythm can also be understood as a system of constraints or rules that shape individuals' actions in space and time (Shapcott & Steadman, 1978). Pacemakers constitute collectively shared, often institutionalised, and above all stable sources of particular rhythms. Building on these earlier conceptualisations, Mulíček et al. (2015: 311) define pacemakers as '*collectively shared, often institutionalised and above all stable sources of particular rhythms.*' The authors further distinguish between two types of pacemakers. The first, *clock-time*

pacemakers, regulate behaviour through fixed start and end points, such as the beginning and end of working hours or scheduled university lectures, whereas *event-time pacemakers* emphasise the duration and sequencing of activities rather than strict adherence to timetables. Pacemakers are therefore understood not merely as isolated temporal markers but as structuring forces contributing to the broader rhythmic organisation of everyday life and mobility. The present paper primarily builds on the concept of clock-time pacemakers.

Pacemakers as relational and temporally variable entities

While these approaches provide an important foundation, interpreting the mobility of working students requires a broader understanding of pacemakers than merely as fixed temporal points coordinating activities in time and space (Parkes & Thrift, 1975) or systems of constraints (Shapcott & Steadman, 1978). For the purposes of this paper, pacemakers are understood more broadly as institutional entities that generate (one, but there may be more) rhythms organising everyday mobility. Importantly, these rhythms need not be homogeneous, as this paper demonstrates that a single pacemaker may generate multiple distinct rhythms. As the findings further illustrate, these rhythms may also change over time. This perspective aligns with Rongna and Sun's (2020) argument that different rhythms operate through different temporal logics, a principle applied here to the conceptualisation of pacemakers. Thus, a substantial part of the present interpretation stems from the limited attention existing approaches devote to the time component of pacemakers and to the possibility that their structuring influence may change across different temporal phases. Existing conceptualisations understand pacemakers primarily as relatively stable institutional sources of rhythms that structure and coordinate everyday temporal organisation (Mulíček et al., 2015). However, such an understanding

tends to treat pacemakers rather statically. Earlier work by Paolucci (2001) suggests that the rhythms organising urban life are not historically constant but change together with broader transformations in work, consumption, and urban temporal structures. Building on this perspective, the present paper argues that temporal variability may also operate within shorter temporal frameworks of everyday life, and even through recurring cycles that structure everyday temporal organisation. In addition, recent rhythm-analytical discussions have highlighted that rhythms continuously interact, synchronise, and temporally coordinate with one another, a dynamic captured by the concept of entrainment. According to Schwanen et al. (2012: 2066), *'entrainment is the process of synchronisation whereby certain elements—Zeitgeber, or pacemakers—impel others to adopt or adjust to their rhythm.'* Entrainment can therefore be understood as the ability of certain rhythms to synchronise other rhythms, since certain rhythms possess a stronger capacity to synchronise, organise, and reorganise other rhythms within everyday life (Schwanen et al., 2012). In Blue's (2019) study, this concept of synchronisation has been further developed. However, rather than treating entrainment as an inherent property of particular rhythms, he conceptualises it as a relational and emergent effect produced through specific configurations of interacting rhythms. Entrainment has been discussed primarily at the level of interacting rhythms; the present paper, instead, argues that the ability to organise and synchronise everyday life also depends on the relational operation of the pacemakers that produce these rhythms. This relational perspective becomes particularly visible in the case of working students, where the ability of university schedules to structure everyday mobility depends strongly on their configuration with work-generated rhythms. Working students, therefore, provide a particularly useful empirical case for examining how pacemakers operate relationally and how their dominance fluctuates across different temporal contexts.

Methodology

Case study

The research was conducted in the Brno metropolitan area, selected for its status as a major "student city" in the Czech Republic. Brno is the second-largest city in the Czech Republic, with more than 400,000 inhabitants, while its metropolitan area comprises over 720,000 residents (Data.Brno, 2025; Metropolitni.Brno, 2025). The analysis focuses on the metropolitan region, as commuting movements predominantly extend beyond the city's administrative boundaries. Brno hosts a dense network of higher education institutions with more than 65,000 students, making it an optimal setting for examining the mobility patterns of working students (Metropolitni.Brno, 2025). The study also forms part of a broader research framework centred on the Brno metropolitan area.

Research design and sampling

This study is based on an online questionnaire survey conducted between March and May 2024. The questionnaire was distributed through multiple social media platforms, including Facebook, Discord, Twitter/X, Instagram, Reddit, and LinkedIn. An online dissemination strategy was selected for its effectiveness in reaching a large number of respondents within a relatively short period of time, given the specific characteristics of the student population. Given students' intensive use of social media platforms, these channels provided an efficient means of data collection. Differences in respondent composition across platforms were observed during data collection. For example, responses collected via Discord were more strongly represented by male students and students from technical disciplines, whereas responses on Facebook were more strongly represented by women. These differences were taken into account during dissemination to achieve a more balanced sample structure across gender and fields of study. The final sample consisted of 680 respondents from all public

universities and several private universities in Brno. Approximately 60% of respondents were bachelor's students, 37% were master's students, and the remaining respondents were doctoral students. The gender structure of the sample was 58% female and 42% male. The sampling strategy aimed to achieve a relatively balanced representation of students from different universities and academic disciplines, while acknowledging existing gender imbalances and varying study conditions across fields. The majority of respondents (53%) resided in Brno, while the remaining 47% lived in smaller municipalities in the city's metropolitan hinterland. A pilot exercise was conducted during the questionnaire development process. Following data collection, all responses were carefully checked and cleaned in order to remove incomplete, unclear, or erroneous entries.

Data analysis

To explore associations between categorical variables describing students' working and mobility patterns, a series of Pearson's chi-square tests of independence was performed. The test was used to assess whether observed distributions of responses differed significantly from those expected under the assumption of independence between variables. Given the categorical nature of the survey data, the chi-square test provided an appropriate method for identifying statistically significant relationships across different dimensions of students' work-study mobility rhythms. The analyses were conducted in two main stages. First, chi-square tests were

applied to explore associations between key dimensions of students' daily organisation, specifically between the dominant pacemaker of the day and the type of working hours or employment contract. Additional tests examined whether the weekly rhythm of work, as reflected in the number of working days, varies significantly across working-hour regimes. All calculations were performed in R 4.3.2.

To explore multidimensional patterns in how students combine study, work, and mobility, a cluster analysis was performed using the Partitioning Around Medoids algorithm. This method was chosen because it is well-suited for categorical data and robust to outliers. The analysis was based on a dissimilarity matrix computed using the Gower distance, which enables the joint inclusion of both nominal and ordinal variables. The variables included in the clustering procedure captured key aspects of students' everyday organisation, namely: level of study, employment status, type of working hours, main pacemaker of the day, and sector of employment. All categorical variables were treated as factors, with missing values explicitly handled, and an ID variable was used to preserve the observation structure.

The number of clusters was determined through silhouette analysis. Among the tested solutions, the configuration with three clusters provided the best trade-off between statistical and interpretative coherence, achieving an average silhouette width of 0.266 (Table 1). The three clusters contained 208, 195, and 277 cases, with average silhouette values of 0.19, 0.26, and 0.32. The distribution of cluster values is shown in Figure 1.

Table 1. Descriptive statistics of cluster values

Cluster	Mean	Median	SD	Min	Max	N
K1	0.191	0.183	0.156	-0.374	0.507	208
K2	0.259	0.209	0.165	-0.084	0.518	195
K3	0.325	0.415	0.175	-0.146	0.514	277
Overall	0.266					680

Note: Mean = average silhouette value; Median = median silhouette value; SD = standard deviation; Min = minimum silhouette value; Max = maximum silhouette value; N = number of observations within each cluster

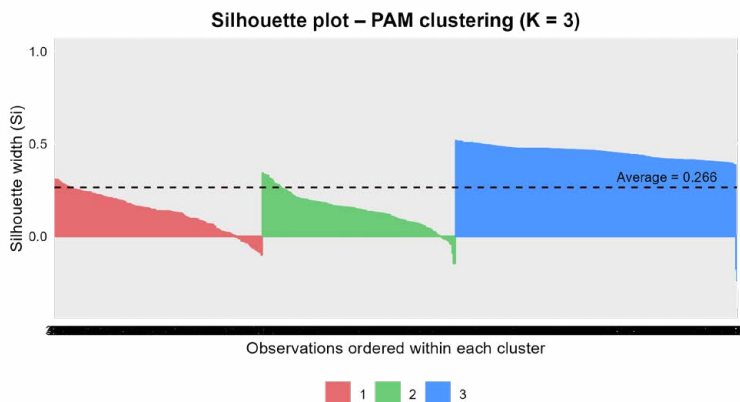


Figure 1. Distribution of cluster values

Note: Statistical analyses were conducted using R

Although the overall silhouette coefficient indicates a moderate degree of separation—typical for complex social-behavioural categorical data—the third cluster exhibited clear internal cohesion, while the remaining two showed moderate overlap. The three-cluster solution was therefore retained as the most parsimonious and interpretable representation of the data. Even though some borderline observations were detected (silhouette < 0.3), subsequent validation procedures confirmed the conceptual stability of the identified clusters. Cluster validity was assessed through complementary quantitative techniques. First, individual silhouette coefficients were examined and visualised to evaluate within-cluster homogeneity and between-cluster separability. Second, associations between cluster membership and selected categorical variables were examined using chi-square tests of independence, followed by Bonferroni-adjusted pairwise comparisons. These tests served to validate the distinctiveness of the clusters and to identify which categorical dimensions contributed most to their differentiation. To ensure the reliability of the pairwise comparisons and to control for potential inflation of the Type I error rate, the Bonferroni correction was subsequently applied. The adjusted significance level was calculated as $\alpha_{\text{adj}} = \alpha/k$, where α denotes the

nominal significance threshold (set to 0.01 in this study), and k is the number of pairwise comparisons. This method maintains the familywise error rate at the pre-specified α level and provides a conservative criterion for statistical significance.

Results

The university as the dominant pacemaker

Students' everyday lives are organised through the interaction of rhythms generated by university and work. The findings indicate that the university timetable functions as the dominant pacemaker in students' everyday lives. Approximately 69% of respondents identified the university schedule as the primary temporal framework structuring their daily routines. This means that the university as a pacemaker produces the dominant rhythm around which students organise paid work, as they are assigned fixed university timetables over which they have little direct control, and these schedules subsequently shape decisions regarding when employment can be performed. In practice, lectures, seminars, exercises, and exams provide the fundamental temporal framework within which most students organise their daily activities. The data further reveal that students whose

daily rhythms are structured primarily by the university schedule are overrepresented in flexible working-hour arrangements (3.44, *standardised residuals*) and underrepresented in fixed working-hour arrangements (-1.92) and hybrid working-hour arrangements (-2.75). This group is also more likely to work part-time (1.50) and less likely to hold full-time employment (-3.69). Not all students, however, identified the university schedule as the dominant temporal framework. For a substantial proportion of respondents, everyday temporal organisation was structured primarily around working hours. In this case, paid work functions as the pacemaker, producing the dominant rhythm that structures everyday life. In contrast to the previous findings, students whose everyday temporal organisation is structured primarily around paid work exhibit the opposite tendency, with overrepresentation in fixed (2.85) and hybrid (4.07) working-hour arrangements, and strong underrepresentation in flexible working-hour arrangements (-5.11). At the same time, students within this group are strongly associated with full-time employment (5.48), while part-time work is comparatively underrepresented (-2.23). These findings indicate that students' everyday lives are organised through the mutual configuration of rhythms produced by the pacemakers of university and paid work. Within the conceptual logic of pacemakers adopted in this article, working-hour arrangements and employment types can be understood as distinct rhythms, or rhythmic configurations, produced by the pacemaker as paid work. Flexible working hours produce a specific rhythm generated

by the paid work pacemaker. The same principle applies to other employment arrangements and employment types. The findings suggest that rhythms generated through flexible and part-time employment arrangements are more compatible with university-generated rhythms, whereas rhythms associated with fixed, hybrid, and full-time employment arrangements are more strongly linked to configurations in which paid work assumes the dominant pacemaking role. Detailed values of the chi-square tests are reported in Table 2.

Rhythmic configurations across the academic year

While the previous section identified dominant pacemakers and the compatibility of rhythms generated by paid work and university schedules, these relationships cannot be understood as stable across the academic year. The dominance of particular pacemakers changes over time, producing different rhythmic configurations of paid work, study, and mobility. To capture these broader temporal configurations, cluster analysis was conducted. Using the PAM method with Gower distance, the cluster analysis grouped the student responses into three clusters. Cluster K1 (N = 208) is characterised during the lecture period primarily by limited participation in paid work, with 60% of students reporting employment on only 1-2 days per week. During the examination period, the distribution shifts towards more frequent employment, with 47% of students reporting working 3-4 days per week. During holidays,

Table 2. Relationship between the main pacemaker and employment characteristics

Main pacemaker	Flexible working-hour arrangements	Fixed working-hour arrangements	Hybrid working-hour arrangements	Full-time employment	Part-time employment
Working hours	-5.11	2.85	4.07	5.48	-2.23
University schedule	3.44	-1.92	-2.75	-3.69	1.50

Note: Results of chi-square tests: $\chi^2 = 73.90$, $df = 2$, $p = 0.00013$ (working-hour arrangements), $\chi^2 = 52.09$, $df = 2$, $p = 0.000029$ (type of employment)

the dominant arrangement corresponds to regular five-day work participation, reported by 55% of respondents. Cluster K2 (N = 195) is associated with the lecture period and is mainly characterised by employment frequencies of 3-4 days per week, reported by 53% of students. In contrast, the examination period is characterised by lower levels of work participation, with 78% of respondents working only 1-2 days per week. During holidays, the distribution again becomes concentrated around regular five-day work participation, reported by 55% of students. Cluster K3 (N = 277) is characterised during the lecture period by generally weak engagement in paid work, with 47% of respondents working 1-2 days per week. During the examination period, employment activity is almost entirely absent, as nearly all respondents (100%) report no paid work participation. During holidays, the distribution shifts towards more regular employment patterns, with 45% of students reporting participation in five-day work. Fig. 2 provides a more detailed illustration of this pattern. To assess statistical significance, a chi-square test was conducted ($\chi^2 = 3934.08$, $df = 64$, $p < 0.001$). The results confirmed that differences in work frequency across the lecture, exam, and holiday periods are highly significant when comparing the clusters.

To examine how these clusters differ with respect to the dominant pacemaker, a chi-square test was conducted between cluster membership and the main temporal pacemaker reported by respondents. The overall test indicated a statistically significant association

($\chi^2 = 9.93$; $df = 2$; $p = 0.007$), suggesting that the clusters differ in the extent to which their daily routines are structured around paid work or university schedules (Table 3). Post-hoc pairwise comparisons with the Bonferroni correction confirmed that the difference was primarily driven by cluster K3, which significantly diverged from both K1 and K2, while the latter two did not differ significantly from each other (Table 4). Analysis of the standardised residuals shows that Clusters K1 (-0.75, *standardised residuals*) and K2 (-1.58) are comparatively less associated with configurations in which paid work functions as the dominant pacemaker, while both clusters are overrepresented among students structured primarily by university-produced rhythms (0.50; 1.06). By contrast, Cluster K3 is concentrated more strongly within configurations dominated by paid work as pacemaker (1.95) and underrepresented among students paced primarily by university-produced rhythms (-1.31). In this respect, Clusters K1 and K2 exhibit relatively similar relationships to the dominant pacemaker. Thus, the test indicates that clusters 1 and 2 do not differ significantly.

Similar test results were obtained for the other characteristics as well. The tests revealed statistically significant relationships in all cases: employment status ($\chi^2 = 9.56$; $p = 0.049$), working-hour arrangements ($\chi^2 = 17.14$; $p = 0.002$), and sector of employment ($\chi^2 = 13.45$; $p = 0.036$). However, the differences between clusters 1 and 2 are statistically insignificant, suggesting that these groups exhibit comparable sociodemographic

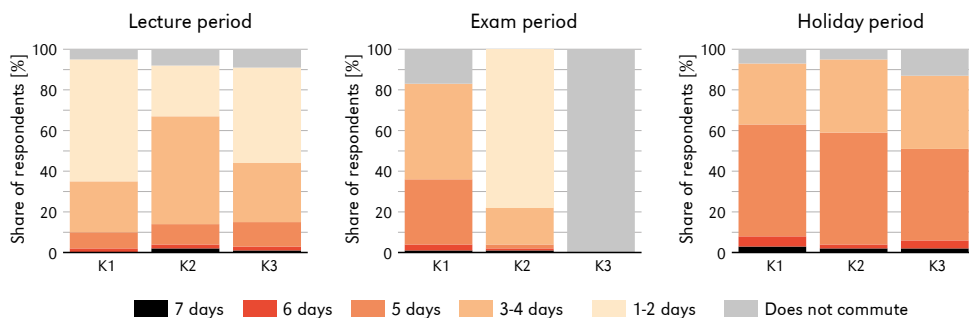


Figure 2. Commuting frequency of working students by cluster across lecture, exam, and holiday periods

Table 3. Standardised residuals for the association between cluster membership and the dominant pacemaker

Main pacemaker	K1	K2	K3
Work schedule	-0.75	-1.58	1.95
University schedule	0.50	1.06	-1.31

Table 4. Pairwise chi-square comparisons between clusters for the dominant pacemaker

Comparison	χ^2	df	p-value	p-value (Bonferroni)
K1 vs K2	1.22	1	0.269	0.806
K1 vs K3	9.28	1	0.002	0.006
K2 vs K3	8.61	1	0.003	0.009

Note: χ^2 = chi-square test statistic; df = degrees of freedom; p-value = significance level of the pairwise chi-square comparison; p-value (Bonferroni) = Bonferroni-adjusted significance level controlling for multiple comparisons

characteristics. Full-time workers are concentrated in K3 (1.97), while part-time workers prevail in K1 (0.65) and K2 (0.23). Differences in the temporal organisation of paid work are also apparent. Students with flexible schedules are overrepresented in K2 (2.10), those with fixed hours in K3 (2.06), and hybrid working-hour arrangements in K1 (1.01). Finally, sectoral composition varies across clusters. K1 is concentrated among students in lower-level services (1.27), while K3 is associated with higher-level (0.95) and quaternary sectors (1.76). K2 exhibits a modest concentration in the primary and secondary sectors (0.58), suggesting links to more traditional or production-oriented forms of employment. Clusters K1 and K2 appear relatively homogeneous in socio-demographic terms, yet their rhythmic behaviour diverges substantially. While both groups comprise similar student profiles, their temporal coordination of paid work and study follows different patterns across the academic calendar. This highlights that the clustering isolates not social categories but distinctive temporal configurations through which students manage multiple rhythms in everyday life. Cluster K3, however, departs from this pattern: it combines a distinct temporal regime with a differentiated socio-demographic profile. Differences between clusters are therefore connected to the sectoral

composition of employment and to corresponding forms of employment contracts and working-hour arrangements. Through these employment arrangements, it becomes possible to observe a direct relationship with mobility behaviour, as different forms of paid work generate distinct rhythms that subsequently shape commuting frequencies and the temporal organisation of everyday mobility.

Discussion

Pacemakers producing multiple rhythms

Everyday mobility of working students unfolds within a polyrhythmic environment (Lefebvre, 2013) constituted through the interaction of multiple institutional rhythms. In particular, university and paid work schedules generate overlapping temporal structures that rhythmise everyday mobility across the academic year. This paper conceptualises the coordination of paid work and university as the interaction of competing institutional regimes structured through the concept of pacemakers. In the context of this study, pacemakers are conceptualised as entities that produce rhythms and, through these rhythms, shape individuals' mobility behaviour. In this analysis, pacemakers are understood as entities that generate multiple qualitatively distinct

rhythms. The university rhythm, for example, cannot be understood as a unified temporal structure. Universities rhythmise everyday life through several distinct rhythms, including those of lectures, seminars, assignment deadlines, and exams, each characterised by a different temporality. This interpretation differs from the interpretation proposed by Mulíček et al. (2015), who primarily conceptualise pacemakers as relatively coherent and stable sources of particular rhythms, such as factory, school, working hours, or shop opening hours. Although they distinguish between different types of urban rhythms, these distinctions do not conceptualise a single pacemaker as internally rhythmically differentiated. The exact temporal characteristics of university-generated rhythms are not directly examined in the data, but their heterogeneous nature (even students within the same study programme may follow different university timetables) can be inferred from the finding that different working arrangements are associated with distinct dominant pacemakers. For example, students for whom the university functioned as the dominant pacemaker were associated predominantly with flexible and part-time employment arrangements, whereas configurations characterised by the stronger influence of the paid work pacemaker were linked to fixed, hybrid, and full-time employment arrangements. This suggests that whether a rhythm becomes dominant depends partly on its temporal characteristics. This theory is more directly observable in relation to the work pacemaker, where working arrangements generate distinct rhythms associated with different commuting frequencies. For example, empirical analysis also revealed that full-time working arrangements were associated predominantly with five-day commuting patterns (11.69, standardised *residuals*), whereas lower commuting frequencies of 1-2 days weekly (2.58) were characteristic primarily of part-time employment. Although this finding may appear unsurprising, its theoretical implications are significant. To conclude this part, the results suggest

that through different working arrangements, it is possible to observe different rhythms produced by paid work functioning as a pacemaker.

Temporal dynamics of pacemakers

The cluster analysis clearly reflected the temporal variability of pacemakers, as all identified clusters exhibited substantial changes in commuting frequencies across the lecture, exam, and holiday periods. For example, Cluster K2 was characterised predominantly by commuting frequencies of three to four days weekly during the lecture period, whereas exam periods were associated mainly with commuting frequencies of only one or two days weekly and holidays with regular five-day commuting participation. These changes in mobility behaviour indicate that the rhythms generated by university and work pacemakers do not remain constant throughout the academic year but change across different temporal phases. This contrasts with previous conceptualisations of pacemakers which have primarily treated them as relatively static structures and neglected their temporal dimension. The present findings, however, suggest that pacemakers need to be examined as entities whose structuring influence changes over time. The case of working students provides particularly valuable empirical material because the academic year is internally differentiated into three distinct temporal periods. Each of these periods is associated with distinct temporal demands and mobility rhythms. For instance, the university as pacemaker generates a qualitatively distinct rhythm during the exam period compared to the lecture period. Taken together, these findings suggest that pacemakers produce multiple qualitatively distinct rhythms whose structuring influence changes across different temporal phases. Pacemakers should therefore not be approached as temporally fixed entities, but rather as dynamic structures whose operation varies across specific temporal periods. In the case of working students, pacemakers

clearly operate through internally differentiated and recurrent temporal cycles that repeatedly reorganise everyday mobility across the academic year.

Pacemakers as relational entities

Recent research conceptualises rhythms as relationally synchronised and coordinated through processes of entrainment (Parkes & Thrift, 1980; Schwanen et al., 2012; Blue, 2019). In the context of working students, this means that rhythms produced by university and work as pacemakers continuously compete, synchronise, and adjust to one another. According to Schwanen et al. (2012), the stronger an element's entraining capacity, the more extensively its effects ripple through everyday life. The dominant pacemaker is the one whose rhythms possess the strongest entraining capacity within a particular temporal configuration.

The present paper applies this relational understanding of rhythms to the conceptualisation of pacemakers themselves. This relational perspective becomes particularly visible in the empirical analysis of working students' mobility rhythms. The cluster analysis provided strong empirical evidence for the relational operation of pacemakers. During the lecture period, the clusters differed substantially in the extent to which everyday mobility remained organised around university-generated rhythms. Some clusters were characterised by commuting participation limited primarily to one or two working days per week, indicating configurations in which university-generated rhythms retained a dominant organising role. Other clusters exhibited substantially stronger incorporation into work-generated rhythms and more regular participation in paid work, suggesting a stronger entraining influence of work-related temporal structures. These relational dynamics became particularly visible during the exam period. While some clusters reduced work participation only partially, work-related mobility within Cluster K3 disappeared almost entirely. This finding suggests

that the organising influence of work-generated rhythms weakened substantially during the exam period, when intensified study obligations and exam preparation strengthened the structuring influence of university-generated rhythms. During the holiday period, however, more regular commuting participation re-emerged across all clusters, indicating another reconfiguration of the relationship between university and paid work as pacemakers. The findings, therefore, suggest that pacemakers' ability to structure everyday mobility depends on their mutual temporal configuration rather than on isolated rhythmic effects.

It follows that pacemakers cannot be understood as isolated or universally operating entities. Instead, they must be conceptualised as structural and relational entities whose influence emerges through interaction with other rhythms. The ability of a pacemaker to rhythmise everyday life fluctuates depending on the configuration of other pacemakers operating within the same relational structure. As demonstrated earlier, the most important pacemakers in the case of working students are the university and paid work. As demonstrated by the empirical analysis, the ability of the university as pacemaker to rhythmise students' everyday lives, more specifically to organise their mobility, depends on its configuration with the paid work as pacemaker. At certain phases of the academic year, the university pacemaker's ability to rhythmise students' everyday lives may become considerably weaker as the paid work pacemaker assumes a dominant role. Importantly, however, the university pacemaker does not cease to function as a pacemaker in such situations; rather, it temporarily loses its dominant position. Furthermore, Schwanen et al. (2012) explicitly challenge deterministic and strictly hierarchical interpretations of entrainment. However, in the example, university study may occupy a more central organising role within students' everyday lives, whereas paid work may be perceived more as a supplementary activity. As a result, the temporal organisation of paid

work may remain, to some extent, individually negotiated. This interpretation also resonates with Rongna and Sun's (2020) discussion of time strategies and temporal decision making, through which individuals actively coordinate and negotiate competing rhythms in everyday life.

Application of this approach

The perspective outlined in this paper is important because understanding pacemakers through their mutual configurations makes it possible to interpret mobility behaviour across different everyday contexts as a product of interacting institutional temporal regimes. This perspective is transferable to other social groups whose everyday mobility emerges through the interaction of multiple institutional rhythms. This includes, for example, parents with childcare responsibilities, whose mobility is continuously organised through the coordination of work schedules, school timetables, childcare opening hours, and care-related routines distributed across different places and times of the day. The same perspective is also applicable to remote workers, whose mobility is shaped through the negotiation between home-based work, digital communication rhythms, flexible workplace attendance, and the periodic need for physical co-presence. Similarly, platform and gig workers operate within highly unstable rhythmic environments in which everyday mobility is repeatedly reorganised through fluctuating work demand, algorithmic management systems, variable working hours, and the temporal unpredictability of platform-based employment. In the present case, this perspective made it possible to provide insight into students' mobility behaviour.

Conclusions

This paper reconceptualises pacemakers as internally differentiated, temporally variable, and relational entities producing multiple rhythms with uneven organising capacities. Their organising influence fluctuates across

recurring temporal phases and through interaction with other institutional rhythms. In the case of working students, university and paid work as pacemakers continuously compete, synchronise, and reorganise one another across the academic year, producing distinct mobility rhythms and commuting patterns. This perspective shifts the understanding of pacemakers away from temporally fixed structures towards dynamic and relational entities whose organising capacities vary across different temporal phases and social configurations. Such a reconceptualisation made it possible to capture how the dominance of the two institutional rhythms changes across the academic year and how these shifting configurations produce differentiated mobility rhythms among working students.

With regard to the empirical findings, the analysis demonstrated that university schedules function as the dominant pacemaker for most students, while the compatibility of work and study depends strongly on the structural, temporal and relational characteristics of the university schedule and working arrangements. The empirical analysis further revealed substantial heterogeneity in students' commuting patterns. Cluster analysis identified three distinct rhythmic mobility configurations that reflected different forms of temporal coordination between study and paid work across the academic year. Variation in commuting frequencies and paid work participation across lecture, exam, and holiday periods further demonstrated the temporally variable operation of pacemakers.

The findings also open new directions for student mobility research by highlighting the importance of examining mobility through the temporal coordination of multiple institutional rhythms. Future research could explore in greater detail how different student groups negotiate competing pacemakers in everyday life, how these rhythmic configurations change over longer temporal trajectories, and how they are experienced in relation to stress, well-being, and everyday mobility strategies. Issues such as well-being, work-life balance, and time poverty

are topics of particular relevance when discussing the group of working students.

Acknowledgements

This research was supported by the Johannes Amos Comenius Programme (P JAC), project No. CZ.02.01.01/00/23_025/0008717, A Mobile Society: Opportunities and Risks of New Forms of Mobility for Czech Society and Economy.

Declaration of interest statement: *The author declare that they have no known com-*

peting financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability statement: *The data that support the findings of this study are available from the corresponding author upon reasonable request.*

Editors' note:

Unless otherwise stated, the sources of tables and figures are the authors', on the basis of their own research.

References

- Amin, A., & Thrift, N. (2002). *Cities: Reimagining the urban*. Cambridge: Polity.
- Blue, S. (2019). Institutional rhythms: Combining practice theory and rhythmanalysis to conceptualise processes of institutionalisation. *Time & Society*, 28(3), 922-950. <https://doi.org/10.1177/0961463X17702165>
- Cadima, C., Silva, C., & Pinho, P. (2020). Changing student mobility behaviour under financial crisis: Lessons from a case study in the Oporto University. *Journal of Transport Geography*, 87, 102800. <https://doi.org/10.1016/j.jtrangeo.2020.102800>
- Camargo, R. M. B., & Sarturi, R. C. (2020). Quem escondeu o ritmo oculto? Um estudo comparado entre os ritmos escolares no Brasil e na França. *Revista e-Curriculum*, 18(3), 1336-1358. <https://doi.org/10.23925/1809-3876.2020v18i3p1336-1358>
- Chim, H. Q., Oude Egbrink, M. G. A., van Gerven, P. W. M., de Groot, R. H. M., Winkens, B., & Savelberg, H. C. M. (2020). Academic schedule and day-to-day variations in sedentary behavior and physical activity of university students. *International Journal of Environmental Research and Public Health*, 17(8), 2810. <https://doi.org/10.3390/ijerph17082810>
- Curtis, S., & Shani, N. (2002). The effect of taking paid employment during term-time on students' academic studies. *Journal of Further and Higher Education*, 26(2), 129-138. <https://doi.org/10.1080/03098770220129406>
- DATA.BRNO. (2025; accessed 15 January 2026). Population data of Brno. <https://data.brno.cz/>
- Edensor, T. (2011). Commuter: Mobility, rhythm and commuting. In T. Cresswell & P. Merriman (Eds.), *Geographies of mobilities: Practices, spaces, subjects* (pp. 189-204). Aldershot: Ashgate. <https://doi.org/10.4324/9781315584393-15>
- EUROSTUDENT. (2024; accessed 12 January 2025). EUROSTUDENT students' employment during the current lecture period. Hanover: DZHW. <https://database.eurostudent.eu/>
- Hägerstrand, T. (1982). Diorama, path and project. *Tijdschrift voor Economische en Sociale Geografie*, 73(6), 323-339. <https://doi.org/10.1111/j.1467-9663.1982.tb01647.x>
- Hall, R. (2010). The work-study relationship: Experiences of full-time university students undertaking part-time employment. *Journal of Education and Work*, 23(5), 439-449. <https://doi.org/10.1080/13639080.2010.515969>
- Holton, M., & Finn, K. (2018). Being-in-motion: The everyday (gendered and classed) embodied mobilities for UK university students who commute. *Mobilities*, 13(3), 426-440. <https://doi.org/10.1080/17450101.2017.1331018>

- Holton, M., & Finn, K. (2020). Belonging, pausing, feeling: A framework of 'mobile dwelling' for UK university students that live at home. *Applied Mobilities*, 5(1), 6-20. <https://doi.org/10.1080/23800127.2018.1477003>
- Kraft, S., Květoň, T., Blažek, V., Pojsl, L., & Rypl, J. (2020). Travel diaries, GPS loggers and smartphone applications in mapping the daily mobility patterns of students in an urban environment. *Moravian Geographical Reports*, 28(4), 259-268. <https://doi.org/10.2478/mgr-2020-0019>
- Kraft, S., Blažek, V., Marada, M., & Mrkvička, T. (2025). Visualising daily commuting flows and travel behaviour of students in Czechia. *Journal of Maps*, 21(1), 2564082. <https://doi.org/10.1080/17445647.2025.2564082>
- Krotká, V. K., & Porkertová, H. (2026). Disability, productivism and temporalities of labour: Rethinking work through crip time. *Scandinavian Journal of Disability Research*, 28(1). <https://doi.org/10.16993/sjdr.1317>
- Lefebvre, H. (2013). *Rhythmanalysis: Space, time and everyday life*. London: Bloomsbury Academic.
- Liao, T. F., Beckman, E., Marzolph, C., Riederer Sayler, J., & Schmelkin, L. (2013). The social definition of time for university students. *Time & Society*, 22(1), 119-151. <https://doi.org/10.1177/0961463X11404385>
- METROPOLITNI.BRNO. (2025; accessed 15 January 2025). Population data of Brno Metropolitan Area. <https://metropolitni.brno.cz/>
- Mulíček, O., Osman, R., & Seidenglanz, D. (2015). Urban rhythms: A chronotopic approach to urban timespace. *Time & Society*, 24(3), 304-325. <https://doi.org/10.1177/0961463X14535905>
- Paolucci, G. (2001). The city's continuous cycle of consumption: Towards a new definition of the power over time? *Antipode*, 33(4), 647-659.
- Parkes, D. N., & Thrift, N. (1975). Timing space and spacing time. *Environment and Planning A*, 7(6), 651-670. <https://doi.org/10.1068/a070651>
- Parkes, D., & Thrift, N. (1980). *Times, spaces, and places: A chronogeographic perspective*. Chichester: Wiley.
- Prazeres, L. (2018). At home in the city: Everyday practices and distinction in international student mobility. *Social & Cultural Geography*, 19(7), 914-934. <https://doi.org/10.1080/14649365.2017.1323343>
- Pusztai, G., & Kocsis, Z. (2019). Combining and balancing work and study on the eastern border of Europe. *Social Sciences*, 8(6), 193. <https://doi.org/10.3390/socsci8060193>
- Rodríguez-Rad, C. J., Revilla-Camacho, M. Á., & Sánchez-del-Río-Vázquez, M. E. (2023). Exploring the intention to adopt sustainable mobility modes of transport among young university students. *International Journal of Environmental Research and Public Health*, 20(4), 3196. <https://doi.org/10.3390/ijerph20043196>
- Rongna, A., & Sun, J. (2020). Integration and sustainability of tourism and traditional livelihood: A rhythmanalysis. *Journal of Sustainable Tourism*, 28(3), 455-474. <https://doi.org/10.1080/09669582.2019.1681437>
- Schwanen, T., van Aalst, I., Brands, J., & Timan, T. (2012). Rhythms of the night: Spatiotemporal inequalities in the nighttime economy. *Environment and Planning A*, 44(9), 2064-2085. <https://doi.org/10.1068/a44605>
- Shapcott, M., & Steadman, P. (1978). Rhythms of urban activity. In T. Carlstein, D. Parkes, & N. Thrift (Eds.), *Human activity and time geography*. London: Edward Arnold.
- Szmelter-Jarosz, A., & Suchanek, M. (2021). Mobility patterns of students: Evidence from Tricity area, Poland. *Applied Sciences*, 11(2), 522. <https://doi.org/10.3390/app11020522>
- Stalmirska, A. M., & Mellon, V. (2022). 'It feels like a job ...' Understanding commuter students: Motivations, engagement, and learning experiences. *Journal of Hospitality, Leisure, Sport and Tourism Education*, 30, 100368. <https://doi.org/10.1016/j.jhlste.2021.100368>
- Wilkinson, S., & Badwan, K. (2021). Walk this way: The rhythmic mobilities of university students in Greater Manchester, UK. *Mobilities*, 16(3), 373-387. <https://doi.org/10.1080/17450101.2020.1833565>