Chapter 8
Time Quality—Measure for Quality of Place

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Abstract The chapter discusses time quality assessment (TQA), a time-people-place oriented approach for evaluation the quality of living environments. The challenge is to shift understanding of city analysis and valuations from two-dimensional land use perspective to dynamic and comprehensive perspective taking into account relationships among users, activities they are engaged with and environments these activities are taking place, analysing there key parameters: time balance, economic balance and time quality balance. It shows that quality of time spent for certain activity in certain place indicates quality of living environments, that it depends on that what a person can afford, and provides evaluation of quality of living environments with a measure of good/bad time. Thus the chapter suggests time as the universal expression and measure of quality of living and challenges planners, decision-makers as well as ordinary people to shape their future having such concept in mind.

8.1 Introduction

The chapter discusses an innovative theoretical approach towards assessing the quality of living environments in terms of the needs of real people, real economic frames as well as spatial qualities and characteristics. The method introduces a time quality assessment approach (TQA) that analyses the quality of space for certain use (activity) and certain users via analysis of quality of time spent for that activity in a particular place or sequences of places. Quality of time spent for an

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activity is a complex function going beyond quantity of time spent for certain activity in a certain place; but combines basic economic ability of a profile, assessment of conduciveness of physical environment and pleasantness of activity taking place there. In relation to development and current state of the art in the field of approaches towards assessing or measuring quality of living, there is a variety of comprehensive concepts of quality of life, usually referring to quantitative social, spatial and economic aspects (e.g. Allen and Gibson 1987; Norris 2001; Oort 2005; Baker and Palmer 2006). Literature review shows that although quality of life is recognised as a general concern, there is little consensus of a definition of quality of life or the factors/predictors of an individual's quality of life (e.g. Blomquist 2006; Lora and Powell 2011). In last decade quality of life concept is focussing also on well-being, health and standard of living addressed via softer indicators such as happiness, life satisfaction and the like (OECD 2013). However, there is still a lack in focus on detailed actual, local level aspects, despite of the fact that many strategic documents (e.g. Territorial Agenda 2020 2011; Leipzig Charter 2007) as fundamental objectives for smart, sustainable and inclusive growth put the importance of local development towards quality of place and well-being of people. In relation to this, Marušić and Goličnik Marušić (2014) argue, that actual implementation of such objectives into real life situations (in scale 1:1) is often vaguely realised. Furthermore these approaches do not suggest a universal measure that can be equally applicable wherever.

The TQA theoretical methodology depends on calibration regarding quality of activity follows, target groups questionnaires, interviews, or appropriate ways of crowd sourcing (e.g. web public participation, social networks), depending on the environment where the approach is applied. Similarly, quality parameters and weights used initially follow a combination of expert knowledge (e.g. sociological studies of everyday life, studies addressing place-making and place attachment—a combination of expert knowledge from the fields of environmental psychology, urban planning and design) and data collected from relevant target groups. The chapter discusses a new approach and illustrates its applicability and value mostly on examples that simulate possible real situations. Comments are based on selected cases, theoretically set up and occasionally proven for some territories, knowing their socio-economic characteristics (source SURS, GURS), place characteristics (e.g. spatial site analysis, behaviour mapping analysis, GURS) and commuting possibilities for the theoretical target profile, using via Michelin or similar portals. To keep the discussion manageable, simplification of parameters or situations is used.

8.2 Time Quality Assesment (TQA)

Hence TQA has been introduced as an alternative approach for assessing effectiveness of human environments for living (Marušić and Goličnik Marušić 2014). In city planning and design, processes the time quality assessment of living environments represents a potential universal baseline.

To implement TQA as a universal evaluation tool for quality of place in relation to its usage, behaviour mapping is seen as a key part of the process, especially where behaviour maps extract behavioural evidence into layers of spatial information to give a better understanding of the individual and collective patterns of use that emerge in a place. Thus, such behaviour maps can be used to capture the knowledge that brings indirect insights of usage-spatial relationships and visualise abstract notions and essentially non-spatial characteristics of physical environments. In relation to TQA, one of the key information offered is time-related characteristics. A behaviour map can show two significant temporal dimensions. Firstly, for how long certain activity is going on in a certain place and secondly, in which day or any other time-unit sequence the activity has been taking place. The chapter explores and introduces a time-place-people-centred approach, supporting low-tech (Goličnik Marušić and Marušić 2012) as well as high-tech (Bahillo et al. 2015) data collection techniques.

Behaviour mapping as a method and tool for analysing user-spatial-temporal relationships provides a conceptual and practical framework that aims to address liveability of places quite directly and describes it with simple everyday measures which are shaping our daily routines and which reflect on actual living situations as much as possible. Based on spatial characteristics, taking into account the character of the activity and economic situation of the subject involved in the activity, TQA approach classifies time spent regarding the activity as such as well as the environment in which the activity is taking place as well or badly spent time; and elucidates backgrounds of user's expectations, affordances and experiences in places (via daily routines). Bottom up approach, human dimensions, real place and time, and 1:1 scale are crucial aspects.

To be able to simulate behaviour of population, behaviour of individuals needs to be known. In TQA approach behaviour is usually defined by daily routine but allows consideration of other situations e.g. weekly routine and extraordinary routine. Those routines are described in relation to individual's needs, obligations and desires. In a personal level (e.g. home) control over the relationships between realised desires, needs and offer is manageable and liveable places in relations to wishes and expectations are often achieved. In bigger scales and more complex environments, where to achieve liveable environments, needs and expectations of many individuals are in question. City making, no matter smart or traditional, is a social process, which in all aspects, from demographic to cultural, economic, structural, ecological and climate, is time and scale sensitive. At the same time city development is an economic activity thus in the process of place creation the classic aspects of economic characteristics, offer, demand and price/value, come into play (see Fig. 8.1). Seeing them in relation to place quality they should assure suitability and affordability reflecting attractiveness of places to users, reasonable facilities for reasonable price and economic accessibility to users; i.e. TQA approach takes into account spatial characteristics and values, socio-economic structure of users and their affordances for place occupancy or consumption (see e.g. Sect. 8.2.2 Economic balance).
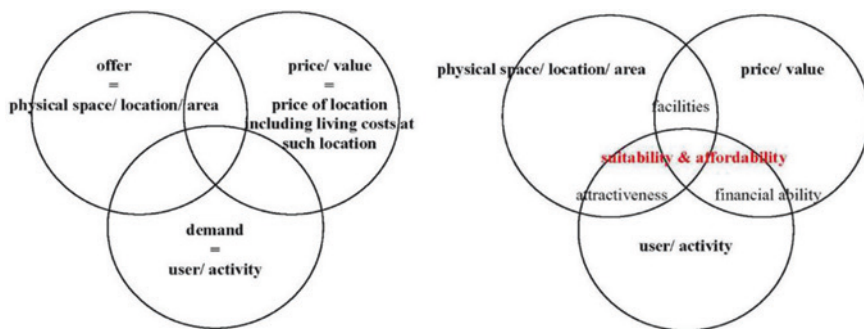
Fig. 8.1 Schematic representation of the background relations relevant for the discussion and development of TQA approach

This reasoning reflects the notion that it is crucial to achieve well-being especially via optimisation of consumption of time, optimisation of services and reduction of costs. In this respect quality of time spent for certain activity in certain place has to do with characteristics of space, characteristics of use in this space reflecting on activity and the person involved with it in the place or sequences of places as well as the money the person has at hand to maintain his/her activities in the place. Thus quality of time spent indicating quality of living environments, depends on that what a person can afford, and provides evaluation of quality of living environments with a measure of good/bad time. TQA approach is based on two time-quality components: activity component and space component. The activity component evaluates potential or most probable satisfaction with the activity within a given time interval, e.g. desired recreation or relaxation would be assigned +100 %, driving a car ±0 %, while compulsory hard labour −100 %. The space component evaluates potential or most probable satisfaction with the place where activity is taking place for given activity within a given time interval, e.g. very suitable and stimulative place for certain activity would be assigned +100 %, a very inappropriate and destimulative place −100 %.

8.2.1 Behaviour Mapping

Activity and space represent a key core examination focus of usage-spatial relationship, an immanent characteristic of behaviour mapping. As a method, tool or source of empirical knowledge behaviour mapping can influence improvements of places for current users or users of similar socio-spatial circumstances of those being observed. However, in combination with TQA approach, offering consideration for socio-economic structure of users and their affordances for place occupancies or consumption, behaviour mapping can help to evaluate quality of living environments. In this respect people friendly and socially inclusive places are places with minimum time waste for their users. They represent places where

residents and other users are able to qualitatively spend their time. Furthermore, such places must enable as broad spectrum of users as possible (e.g. considering peoples' age, socio-economic situations, ethnic groups, impaired people, etc.) to fully fulfil their needs and expectations.

In summary the challenge of this concept is to shift understanding and focus about data sets for city analysis towards people and places. Assisted with behaviour mapping, this alternative approach would provide a time-based perspective on the activities and engagement of *people*.

8.2.2 Place

There are two basic types of properties of places: programmes in places and communications between them. In classic spatial planning language programmes would refer to land uses, communications to infrastructure. However, nowadays such perspective is often too narrow especially taking into account dynamic character of cities and manifestations of various activities in same places at different times. In such context land use approach promoting single-view and sectorial dealing with spatial reality omits multi-functionality of territories (e.g. a park may be well used for recreation as well as for cultural events at different or even the same time). Therefore uses and offers of places are referred to as programmes. Necessary programmes are, for example, dwelling, working, attending to the basic services. Other activities within a daily routine are classified as optional or desired, such as leisure, recreation (e.g. sport, culture) and other services (e.g. hairdressing). Each such spatial component—programmes based in the building or in an open space and the communication between them—has its basic purpose. Places are evaluated against their prime purpose as well as to any other potential activity they might stimulate. Thus two components of the place are taken into consideration:

- what a person is doing in a place (activity component, AC);
- in what kind of environment the activity is taking place (space component, SC).

Both components are assessed with quality of time spent. Final suitability of the location for one or more activities is calculated as the parameter *quality of activity component of time* (F_{QAC}), i.e. quality of time involved in action as such, and *quality of spatial component of time* (F_{QSC}), i.e. quality of time spent in a certain environment.

To illustrate the concept, the example below shows calculated F_{QAC} and F_{QSC} for a simple daily routine of commuting for a person P (or representative profile of users). The person P is shown to have four possibilities for going about daily business: by car, by bus, by bicycle, by foot. Each routine regarding the means of transport is different; each involves different places and results in various times of satisfaction, which in this context finally leads towards quality of living environments. The resulting calculations are presented in Table 8.1 for commuting

Table 8.1 Time spent (T_{Sp}) and quality of activity (F_{QAC}, %) and spatial (F_{QSC}, %) components of time in commuting section of a daily routine of a selected profile (P)

Activity		By car (incl. walking and parking time)					Sum	By bicycle (incl. walking and parking time)					Sum
		Going to nursery	Going to work	Going from work, to pick up children	Going from work and shopping	Going home		Going to nursery	Going to work	Going from work, to pick up children	Going from work and shopping	Going home	
P	T_{Sp}	15	15	15	10	15	70	10	15	15	10	10	60
	F_{QAC}	0	0	0	0	0		50	50	50	50	50	
	F_{QSC}	−50	−10	−10	−50	−50		−20	−10	−10	−20	−20	

activities by car or traveling by bicycle. For example it shows that in this scenario the person completes his/her journey faster by bicycle than by car. Furthermore it shows that cycling, as an activity, is more enjoyable even though comparative experiences do not differ much. However the cyclist has the opportunity to choose slightly friendlier route. This is a preliminary analysis with no time quality related qualifications yet.

8.2.3 User Perspective

A key focus of TQA approach is that quality of time spent indicates quality of living environments. At this stage the model introduces an economic component, which finally relates to costs of time spent and expresses the quality of activity user is involved with in temporal dimension.

The following example addresses user's valuation of optional activity in his daily routine, in the case of recreational swimming. It shows that there are two different valuations of the same time by two different recreational swimmers (S1, S2), of which each earn 12 EUR/h. Each of them pre pays timetabled hour of swim (6 EUR). They are both running late by 5 min. S1 does not want to lose any minute of swimming and takes a taxi to the swimming pool. He arrives on time. S2 walks to the swimming pool along the nice neighbourhood and arrives 10 min late. As they both have to finish swimming at fixed time, S1 has been swimming for 60 min, S2 for 50 min. However, S2 considered his walk as valuable as swimming; so, S2 does not feel he lost 10 min of recreation. Moreover, S2 might even feel he gained 5 min of recreation. S2 did not spend any extra money. S1 completed his 60 min of recreation and spent some extra money for a taxi. S1 paid 6 EUR for swimming pool and 6 EUR for a taxi to enjoy 60 min of swimming. The price was 12 EUR for 60 min of recreation. S2 spent money only for swimming pool. The price was 6 EUR for 65 min of recreation (50 min of swimming +15 min for walking). They both spent 65 min for both activities commuting to the pool and swimming in the pool, but they were willing to pay different price for the same activity (swimming). S1 paid 12 EUR for 60 min of swimming (20 cents/1 min of swimming); S2 paid 6 EUR for 50 min of swimming (12 cents/1 min of swimming). Time spent in the swimming pool as well as time spent for commuting to the pool were valuated differently (Table 8.2).

When addressing quality of living, quality of time spent for recreation matters. As shown above, S1 had 60 min of good time (recreation), S2 had 65 min of good time (recreation). Speaking in time-dimensions, for these 60 min of good time, S1 consumed one working hour and 5 min of taxi driving, i.e. 65 min of bad time (time spent for working is considered as a bad time). S2 spent 65 min of good time and consumed for that only half working hour, i.e. 30 min of bad time. The value of and the price for time spent differ very much. S2 gets higher value for lower price.

Table 8.2 Quality of engagement with activity in relation to valuation of time spent for that in the case of two recreational swimmers, S1 and S2

Person	Recreation entrance (EUR)	Circumstances	Solution	Swimming time (min)	Value of time spent	Costs of time spent (EUR)	Time-costs of time spent*
S1	6	5 min late	Taxi on time	60	60 min of good time	12	65 min of bad time
S2	6	5 min late	Walking 15 min late	50	65 min of good time	6	30 min of bad time

*The simplification is used to illustrate the first step of TQA analysis (quality of activity, F_{QAC}): time invested in recreation is considered as a good time; time invested in working ours to earn money to be able to afford payable recreation is considered as a bad time

Table 8.3 Affordance—economic impact on carrying out optional activity such as recreational swimming for two persons of different incomes (P1, P2), who go to recreation by foot

Person	Earnings (EUR/h)	Activity (good time) [min]	Costs (EUR)	Commuting 1* (bad time) [min]	Working (bad time) [min]	Total good time (min)	Total bad time (min)
P1	72	60	6	10	5	60	15
P2	12	60	6	10	30	60	40

*To keep the discussion simple, the example here assumes that walking takes a short cut, passing unpleasant environments, therefore it is considered as bad time

8.2.4 Economic Perspective

So far the discussion addressing the TQA approach characteristics shows comments on activities in relation to the means of transport and sequences of places on the way (subchapter 8.2.2), and valuation of consumed time for an activity (subchapter 8.2.3). At this point discussion is upgraded with the economic frame of a person (profile) and shows its impacts on affordability of activity in places for a chosen profile. For example, there are two persons (P1, P2) with different incomes who go for 60 min of swimming. As already shown in the discussion so far in TQA approach, in a simplified case, there are three time corpuses which matters: time for activity in focus, time for going there, and time of work in which a person earns enough to be able to do the activity and go to the activity. P1 earns 72 EUR/h, P2 earns 12 EUR/h (P1 earns 6xP2). Swimming hour costs 6 EUR. If P2 is walking to the swimming pool for 10 min and swimming for 60 min he/she must work for that commodity for 30 min, as the only cost is the entrance to the swimming pool (6 EUR). So, for 60 min of swimming (good time) P2 has to invest in total 40 min of commuting* and working (bad time) (Table 8.3). If P2 takes a taxi to the swimming pool it costs 6 EUR and takes 5 min. In such case P2's time balance is as follows: for 60 min of swimming (good time), P2 invests 5 min of commuting and 60 min of work (30 min to pay a swimming pool and

Table 8.4 Affordance—economic impact on carrying out optional activity such as recreational swimming for two persons of different incomes (P1, P2), who go to recreation by a taxi

Person	Earnings (EUR/h)	Activity (good time) [min]	Costs (EUR)	Commuting 2 (bad time) [min]	Working (bad time) [min]	Total good time (min)	Total bad time (min)
P1	72	60	12	5	10	60	15
P2	12	60	12	5	60	60	65
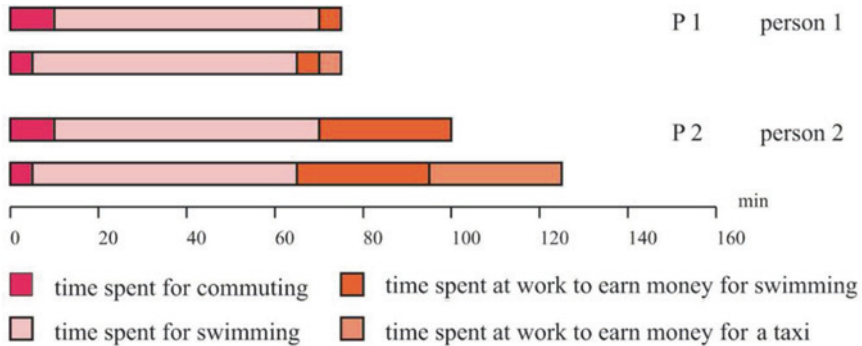
Fig. 8.2 Comparative illustration of time investment of P1 and P2 to afford recreational swimming

30 min to pay a taxi) (Table 8.4). In total, for P2 the bad time (65 min) prevails the good time (60 min). So, to keep living good in the area P2 cannot afford to take a taxi to the swimming pool (Tables 8.3 and 8.4).

On the contrary, for 60 min of swimming and going there by foot, in time measures P1 spent 10 min for walking and 5 min of working hour for the entrance. So, for 60 min of a good time (swimming) P1 invests 15 min of bad time (Table 8.3). In case that P1 takes a taxi (Table 8.4), situation in terms of time quality balance is the same: for 60 min of swimming P1 invests 5 min of commuting by a taxi and 10 min of work (5 min for paying a taxi, 6 EUR; 5 min for paying the swimming pool, 6 EUR). In the case of the person who earns more money (P1) the price in bad time for the unit of good time is the same in both arrangements. For such a profile it is irrelevant which way of transport to the swimming pool the person chose, while the other person makes his quality of living much worse. If chose to go by taxi the total balance is 5 min of bad time and 0 min of good time (Fig. 8.2).

8.2.5 Time Perspective

TQA approach divides the time spent for any activity into the good or the bad portion. The remaining time is considered as neutral portion of time. As shown in subchapter 8.2.2, initial analysis is related to time spent for the activities and

to basic qualities of activities and places. Further evaluation with time as the universal measure for quality of environments by weighting using the parameters (F_{WAC}, F_{WSC}). The weight of each quality component describes how much each component contributes to potential quality of time, e.g. potential satisfaction with the time spent in the given place (see Tables 8.5 and 8.6). These two parameters finally shape the activity-place relationship in a daily routine, and are for comparative purpose finally transferred into coefficient of time quality and quality time balance (K_{TQ} and T_Q).

In all the examples referring to implementation of TQA approach, the following parameters are assessed and/or calculated:

T_{Sp} time spent (hours, minutes)
F_{QAC} quality of activity component of time (%)
F_{QSC} quality of spatial component of time (%)
F_{WAC} weighting of activity component of time (%)
F_{WSC} weighting of spatial component of time (%)
K_{TQ} coefficient of time quality
T_Q quality time (hours, minutes)

Relations among the measures of activity-place relations in a daily routine (see Tables 8.5 and 8.6) show for example, that for the selected chosen profile daily shopping represents 20 min. Activity of basic goods shopping is compulsory therefore it is assessed as indifferent ($F_{QAC} = 0$ %) and as such does not represent high influence ($F_{WAC} = 20$ %) in comparison to the space as such (shop) and its location. In this case spatial components of time have bigger influence on time quality experience that the activity ($F_{QSC} = 20$ %, $F_{WSC} = 80$ %). Time quality balance shows that in such situation for 20 min of shopping 3 min represent a quality time. Having a look on optional activity, e.g. gym for which the profile spent 2 h, it is classified as desirable and enjoyable activity ($F_{QAC} = 100$ %), also the place where the activity is taking place is recognised as comfortable, well facilitated, well located, designed and maintained, and as such represents important influence on the entire satisfaction ($F_{QSC} = 80$ %, $F_{WSC} = 40$ %), although influence of the activity plays bigger role ($F_{WAC} = 60$ %). Final assessment of quality of usage-spatial satisfaction shows that in 2 h the person gains 1 h and 50 min of quality time which ranks the gym with its surrounding as high quality place.

8.3 Time Quality

TQA approach examines relationships between users (characteristic socio-economic profiles acting in certain environments), their activities and the relevant environments in terms of three key parameters: time balance, financial balance and time quality balance. Time balance shows how comfortable the time is spent by the user in his/her (living) environments. Economic balance is a category, which represents subject's incomes and expenses for essential and optional activities, and

Table 8.5 Activity-place relations and quality time balance (T_Q) for total daily routine for profiles Pa (live close to work) and Pb (live far from work) regarding commuting by car. Theoretical simulation by authors, Ljubljana, spring, 2013

Place		Home	Home	Street	Nursery	Street	Work	Street	Nursery	Street	Shop	Street	Street	Gym	Street	Home	Home	Home
Activity		Sleeping	Getting up and breakfast	Going to nursery	Dropping of children	Going to work	Working	Going to nursery	Picking up children	Going to do shopping	Daily shopping	Going home	Going to recreation	Recreation	Coming from recreation	Dinner	Home with a family	
Pa	T_{Sp}	8 h 0'	30'	15'	5'	15'	8 h 0'	15'	5'	10'	20'	15'	10'	2 h 0'	10'	30'	3 h 0'	24 h 0'
	F_{QAC}	100	0	0	0	0	-20	0	0	0	0	0	0	100	0	100	100	
	F_{QSC}	80	80	-50	-10	-10	0	-10	-10	-50	20	-50	-50	80	-50	80	80	
	F_{WAC}	50	40	60	40	60	50	60	40	60	20	60	60	60	60	50	50	
	F_{WSC}	50	60	40	60	40	50	40	60	40	80	40	40	40	40	50	50	
	K_{TQ}	0.90	0.48	-0.20	-0.06	-0.04	-0.10	-0.04	-0.06	-0.20	0.16	-0.20	-0.20	0.92	-0.20	0.90	0.90	0.48
	T_Q	7 h 12'	14'	-3'	0'	-1'	-48'	-1'	0'	-2'	3'	-3'	-2'	1 h 50'	-2'	27'	2 h 42'	11 h 27'
Pb	T_{Sp}	8 h 0'	30'	15'	5'	20'	8 h 0'	20'	5'	10'	20'	15'	10'	2 h 0'	10'	30'	2 h 50'	24 h 0'
	F_{QAC}	100	0	0	0	0	-20	0	0	0	0	0	0	100	0	100	100	
	F_{QSC}	80	80	-50	-10	-10	0	-10	-10	-50	20	-50	-50	80	-50	80	80	
	F_{WAC}	50	40	60	40	60	50	60	40	60	20	60	60	60	60	50	50	
	F_{WSC}	50	60	40	60	40	50	40	60	40	80	40	40	40	40	50	50	
	K_{TQ}	0.90	0.48	-0.20	-0.06	-0.04	-0.10	-0.04	-0.06	-0.20	0.16	-0.20	-0.20	0.92	-0.20	0.90	0.90	0.47
	T_Q	7 h 12'	14'	-3'	0'	-1'	-48'	-1'	0'	-2'	3'	-3'	-2'	1 h 50'	-2'	27'	2 h 33'	11 h 18'

Table 8.6 Activity-place relations and quality time balance (T_Q) for total daily routine for profiles from the same neighbourhood; Pa (live close to work), Pb (live far from work) and Pc (living place characteristic with bad spatial characteristics)

Place	Activity	Home Sleeping	Home Getting up and breakfast	Street Going to nursery	Nursery Dropping of children	Street Going to work	Work Working	Street Going to nursery	Nursery Picking up children	Street Going to do shopping	Shop Daily shopping	Street Going home	Street Going to recreation	Gym Recreation	Street Coming from recreation	Home Dinner	Home Home with a family	Home
Pa	T_{Sp}	8 h 0'	30'	10'	5'	15'	8 h 0'	15'	5'	10'	20'	10'	10'	2 h 0'	10'	30'	3 h 10'	24 h 0'
	F_{QAC}	100	0	50	0	50	−20	50	0	50	0	50	50	100	50	100	100	
	F_{QSC}	80	80	−20	−10	−10	0	−10	−10	−20	20	−20	20	80	20	80	80	
	F_{WAC}	50	40	40	40	40	50	40	40	40	20	40	40	60	40	50	50	
	F_{WSC}	50	60	60	60	60	50	60	60	60	80	60	60	40	60	50	50	
	K_{TQ}	0.90	0.48	0.08	−0.06	0.14	−0.10	0.14	−0.06	0.08	0.16	0.08	0.32	0.92	0.32	0.90	0.90	0.50
	T_Q	7 h 12'	14'	1'	0'	2'	−48'	2'	0'	1'	3'	1'	3'	1 h 50'	3'	27'	2 h 51'	12 h 2'
Pb	T_{Sp}	8 h 0'	30'	10'	5'	25'	8 h 0'	25'	5'	10'	20'	10'	10'	2 h 0'	10'	30'	2 h 50'	24 h 0'
	F_{QAC}	100	0	50	0	50	−20	50	0	50	0	50	50	100	50	100	100	
	F_{QSC}	80	80	−20	−10	−10	−20	−10	−10	−20	20	−20	20	80	20	80	80	
	F_{WAC}	50	40	40	40	40	50	40	40	40	20	40	40	60	40	50	50	
	F_{WSC}	50	60	60	60	60	50	60	60	60	80	60	60	40	60	50	50	
	K_{TQ}	0.90	0.48	0.22	−0.06	0.26	−0.10	0.26	−0.06	0.22	0.16	0.22	0.32	0.92	0.32	0.90	0.90	0.50
	T_Q	7 h 12'	14'	2'	0'	7'	−48'	7'	0'	2'	3'	2'	3'	1 h 50'	3'	27'	2 h 33'	11 h 57'
Pc	T_{Sp}	8 h 0'	30'	10'	5'	15'	8 h 0'	15'	5'	10'	20'	10'	10'	2 h 0'	10'	30'	3 h 10'	24 h 0'
	F_{QAC}	100	0	50	0	50	−20	50	0	50	0	50	50	100	50	100	100	
	F_{QSC}	20	70	−20	−10	−10	0	−10	−10	−20	20	−20	20	80	20	70	70	
	F_{WAC}	50	40	40	40	40	50	40	40	40	20	40	40	60	40	50	50	
	F_{WSC}	50	60	60	60	60	50	60	60	60	80	60	60	40	60	50	50	
	K_{TQ}	0.60	0.42	0.08	−0.06	0.14	−0.10	0.14	−0.06	0.08	0.16	0.08	0.32	0.92	0.32	0.85	0.85	0.39
	T_Q	4 h 48'	13'	1'	0'	2'	−48'	2'	0'	1'	3'	1'	3'	1 h 50'	3'	26'	2 h 42'	9 h 26'

a financial frame within which the subject is flexible to perform relevant activities in a certain environment. Whilst lastly time quality balance calculates time spent in terms of both activity and environment.

8.3.1 Time Balance

Time spent for each action should be shorter or equal to available time for that action:

$$T_{Rqi} \leq T_{Avi}.$$

where

T_{Rqi} time required for action i
T_{Avi} time available for action i

Sometimes one does not manage an activity within the available time, so the person is late. However, the minimum required condition, yet not always sufficient, is to perform everything that is required in the whole available time (e.g. to do all daily routines in 24 h):

$$\sum_i T_{Rqi} \leq \sum_i T_{Avi} \rightarrow T_{Rq} \leq T_{Av}$$

Time balance analysis shows balance of essential and optional activities. In the situation of assessing suitability of neighbourhood for certain profile, a first checking criterion at the level of time balance is profile's ability to fulfil activities. If the profile is not able to fulfil necessary activities the neighbourhood is not suitable for it, if the profile is not able to fulfil optional activities, optional activities must be re-organised against a new priority list.

8.3.2 Economic Balance

The basic information addressed is household's incomes and expenses for necessary activities and optional activities. Expenses of a household should not exceed the incomes:

$$\sum_i M_{Rqi} \leq \sum_j M_{Avj} \rightarrow M_{Rq} \leq M_{Av}$$

where

M_{Rqi} money required for expense i
M_{Avi} money available from the source j

Incomes are classified as regular (e.g. salary earned in working time every working day); other regular (e.g. pension, rent); and irregular (e.g. property

selling). Expenses are classified as: residential expenses; basic basket expenses (e.g. food, clothes); other necessary expenses (e.g. nursery, school); other optional expenses and; travel expenses for commuting at daily routine.

8.3.3 Time Quality Balance

Time quality balance shows when financial situation allows the activities to happen, how well the time required is spent; how much of the entire time taken for all the activities per day is considered as being good quality and how much of bad quality. This balance shows final quality of time spent within a routine and reflects on quality of living environment one lives in. Thus with this final parameter the TQA approach shows whether a segment of population can live in certain area and how comfortable.

$$K_{TQ} = \frac{T_Q}{T_{Sp}} = \frac{\sum_i T_{Qi}}{\sum_i T_{Spi}} = \frac{\sum_{ij} T_{Spi} \times F_{Qij} \times F_{Wij}}{\sum_i T_{Spi}}$$

where $\sum_j F_{Wij} = 1$ and $-1 \leq F_{Qij} \leq 1$

where

K_{TQ} time-quality coefficient
T_Q evaluated portion of time ($+$ signed: good time; $-$ signed: bad time)
T_{Qi} evaluated portion of time within the time interval i
T_{Sp} time spent
T_{Spi} time spent within the time interval i
F_{Qij} quality of the quality component j within the time interval i
F_{Wij} influence (weight) of the quality component j within the time interval i

In the examples presented at least two time-quality components are proposed:

AC   activity component
SC   space component

Therefore:

$$j \in \{AS, SC\} \Rightarrow F_{Wi,SC} = 1 - F_{Wi,AC}$$

The following comparative simulation shows that in the case when daily routine is performed by bicycle, no matter job location (Pa job is closer than in case Pb), a person gains more quality time per day than when he is driving a car to get all the daily activities done.

Simulating quality time balance for the same profile, with exactly the same daily routine, living in the same neighbourhood, but at the other side, close to the heavy traffic road and railway line, would show that quality time balance would decrease, especially as quality of spatial component of time for sleeping, which

in the previous case represents a great portion of good quality time (8 h), is considered as bad. In such case instead of having 12 h 2′ of a good quality of time per day the person has 9 h 26′ of a good quality of time per day (K_{TQ} is 0.39) (see Table 8.6).

8.4 Practical Relevance

Implementing TQA approach, it has to be born in mind that time balance and economic balance are absolute objective measures, whilst time quality balance is always subjective. Hence it shows how one place may be better (e.g. provides higher benefit/comfort for the user) than the other and always needs to be commented regarding the context. In this respect although economic balance represents an absolute value, it is linked to location. When applying TQA approach it is necessary to define some characteristic individual profiles, which can help to describe the population in the studied area. Such profiles are set up from available statistical data or any other relevant source (e.g. questionnaire) regarding demographic and social parameters such as: age, gender, family status, education, occupation, income, and the like.

Based on crucial boundary characteristics all possible variations of individual profiles, which are assumed to be realistic, are defined. Realistic profiles are designed by logical filters or on the basis of known data about the population of the area of interest. Having defined possible real boundary profiles of the population, the assumption is, if those boundary profiles are satisfied, all profiles within the studied segment of population is covered. On the basis of individuals' profiles it is possible to define limits of population of the studied area and edge conditions of/for such population within the area.

For the purpose of making elderly people living easier, a pilot testing assessment of quality of living environments via quality of time was modelled for a local district in the northern part of the city of Ljubljana (Goličnik Marušić and Marušić 2013). The profile was defined based on socio-economic statistical data. Data on time and activity was collected on the basis of combination of approaches: field work related to spatial analysis, including facilities and services (e.g. open/green space, recreation, culture, public transport), and accessibility; pilot behaviour observation of selected areas to get an idea of behaviour patterns of elderly in the area, including duration of activities in the environment (e.g. how much time they spent to come from A to B, how much time do they spent in local park or library). An interview with the active member of local community, an elderly person living in high raised flats area, was conducted including questions of daily routine there, environmental, social and economic commodity of living there and the like. Parameters calibration was done on combination of discipline tacit knowledge, expert knowledge and target groups involvement; space component as a combination of field work, cartographic materials, expert knowledge and target groups involvement (indirectly with behaviour mapping, directly via interview); activity
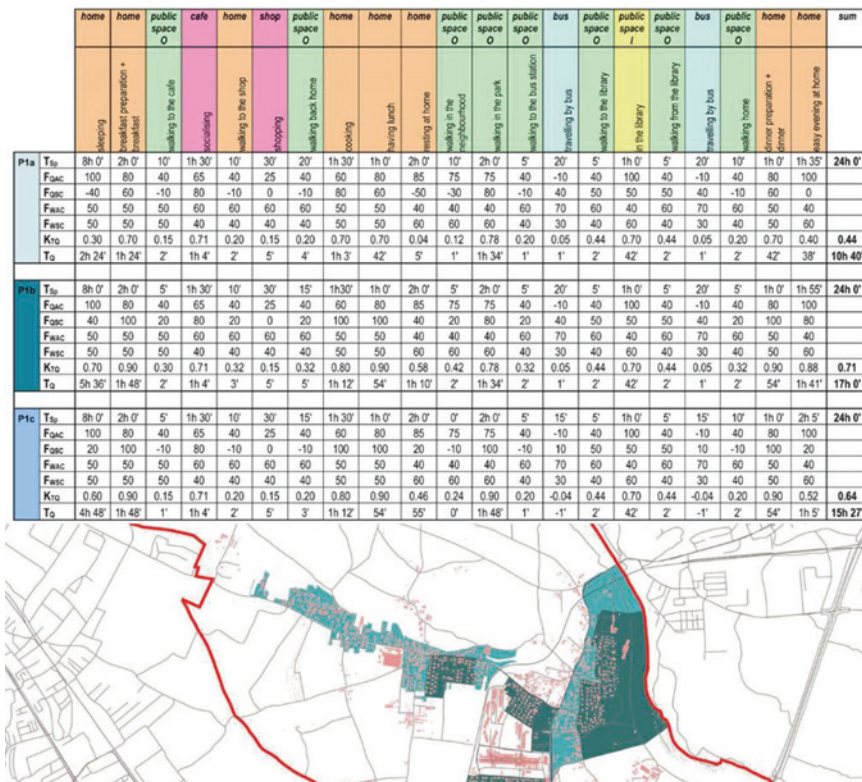
		home	home	public space o	cafe	home	shop	public space o	home	home	home	public space o	public space o	public space o	bus	public space o	public space i	public space o	bus	public space o	home	home	sum
		sleeping	breakfast preparation + breakfast	walking to the cafe	socialising	walking to the shop	shopping	walking back home	cooking	having lunch	eating at home	walking in the neighbourhood	walking in the park	walking to the bus station	travelling by bus	walking to the library	in the library	walking from the library	travelling by bus	walking home	dinner preparation + dinner	easy evening at home	
P1a	T_{sp}	8h 0'	2h 0'	10'	1h 30'	10'	30'	20'	1h 30'	1h 0'	2h 0'	10'	2h 0'	5'	20'	5'	1h 0'	5'	20'	10'	1h 0'	1h 35'	24h 0'
	F_{QAC}	100	80	40	65	40	25	40	60	80	85	75	75	40	-10	40	100	40	-10	40	80	100	
	F_{QSC}	-40	60	-10	80	-10	0	-10	80	60	-50	-30	80	-10	40	50	50	40	-10	60	0		
	F_{WAC}	50	50	50	60	60	60	60	50	50	40	40	40	60	70	60	40	60	70	60	50	40	
	F_{WSC}	50	50	50	40	40	40	40	50	50	60	60	60	40	30	40	60	40	30	40	50	60	
	K_{TQ}	0.30	0.70	0.15	0.71	0.20	0.15	0.20	0.70	0.70	0.04	0.12	0.78	0.20	0.05	0.44	0.70	0.44	0.05	0.20	0.70	0.40	**0.44**
	T_Q	2h 24'	1h 24'	2'	1h 4'	2'	5'	4'	1h 3'	42'	5'	1'	1h 34'	1'	1'	2'	42'	2'	1'	2'	42'	38'	**10h 40'**
P1b	T_{sp}	8h 0'	2h 0'	5'	1h 30'	10'	30'	15'	1h30'	1h 0'	2h 0'	5'	2h 0'	5'	20'	5'	1h 0'	5'	20'	5'	1h 0'	1h 55'	24h 0'
	F_{QAC}	100	80	40	65	40	25	40	60	80	85	75	75	40	-10	40	100	40	-10	40	80	100	
	F_{QSC}	40	100	20	80	20	0	20	100	100	40	20	80	20	40	50	50	40	20	100	80		
	F_{WAC}	50	50	50	60	60	60	60	50	50	40	40	40	60	70	60	40	60	70	60	50	40	
	F_{WSC}	50	50	50	40	40	40	40	50	50	60	60	60	40	30	40	60	40	30	40	50	60	
	K_{TQ}	0.70	0.90	0.30	0.71	0.32	0.15	0.32	0.80	0.90	0.58	0.42	0.78	0.32	0.05	0.44	0.70	0.44	0.05	0.32	0.90	0.88	**0.71**
	T_Q	5h 36'	1h 48'	2'	1h 4'	3'	5'	5'	1h 12'	54'	1h 10'	2'	1h 34'	2'	1'	2'	42'	2'	1'	2'	54'	1h 41'	**17h 0'**
P1c	T_{sp}	8h 0'	2h 0'	5'	1h 30'	10'	30'	15'	1h 30'	1h 0'	2h 0'	5'	2h 0'	5'	15'	5'	1h 0'	5'	15'	10'	1h 0'	2h 5'	24h 0'
	F_{QAC}	100	80	40	65	40	25	40	60	80	85	75	75	40	-10	40	100	40	-10	40	80	100	
	F_{QSC}	20	100	-10	80	-10	0	-10	100	100	20	-10	100	-10	10	50	50	50	10	-10	100	20	
	F_{WAC}	50	50	50	60	60	60	60	50	50	40	40	40	60	70	60	40	60	70	60	50	40	
	F_{WSC}	50	50	50	40	40	40	40	50	50	60	60	60	40	30	40	60	40	30	40	50	60	
	K_{TQ}	0.60	0.90	0.15	0.71	0.20	0.15	0.20	0.80	0.90	0.46	0.24	0.90	0.20	-0.04	0.44	0.70	0.44	-0.04	0.20	0.90	0.52	**0.64**
	T_Q	4h 48'	1h 48'	1'	1h 4'	2'	5'	3'	1h 12'	54'	55'	0'	1h 48'	1'	-1'	2'	42'	2'	-1'	2'	54'	1h 5'	**15h 27'**

Fig. 8.3 TQA assessment results showing the best quality of living for the representative profile are areas of individual houses. The area including public elderly home accommodation resulted as the less qualitative (Goličnik Marušić and Marušić 2013)

component target groups involvement (indirectly with behaviour mapping, directly via interview). Time and economic balance of the profile was assessed as positive. Time quality assessment for a daily routine of a profile living in three different types of locations (high rise flats area including elderly people accommodation, 1a; area of individual houses, 1b; area of compact rural settlement, 1c) within the area was simulated using TQA approach (see Fig. 8.3).

8.5 Conclusion

The TQA approach proposes time as the universal expression and measure of quality of living, using time balance, economic balance and time quality balance as the key indicators to calculate possibility and comfort of living in the given environment. Data as results of such approach are linked to locations and user

profiles and are therefore useful for comparison of profiles within different location of the area, and judgement about suitability of certain location in the area for varies profiles. Capability of contemporary ICT tools, which serves as an interface between place and people, can play a significant role to automate data. Especially, monitoring tools consisting of a smart phone application, a set of web services, and the cloud can give very informative and rich information about parameters relevant for TQA approach. Bahillo et al. (2015), for example, upgraded and used such tool for behaviour mapping in public spaces and collect detailed spatial-temporal information about people's engagement in places, agreed profile's descriptive information (e.g. gender, age group, occupation), positions, answers on contextual questions as well as augmented reality suggestions. Such technology enables insights into real bottom-up understanding of daily routines and circumstances people are involved with and is worth linking it with TQA in further development of the approach and its implementation.

Information offered by TQA approach is useful for any kind of place user, from individuals to check locations e.g. where to live or work, to decision-makers at various governance levels. Distribution of such information is possible through upgrade of existing available information systems. Such information is under constant refinement process referring to two main sources: available geoinformatics and spatial data, and direct and indirect participatory data. TQA as a monitoring or development control approach is applicable for authorities and individuals for setting new developments in a place, searching for measures of improvements, comparison of different locations for one particular use, and comparison for various measures in a certain location.

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