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Constraints to implementation of sustainability indicator systems in five Asian cities

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Constraints to implementation of sustainability indicator systems in five Asian cities

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Contemporary studies on sustainability indicator systems (SISs) typically focus on the technical advancement of indicator construction, on qualitative impacts of indicator programmes and on impacts on governance, decision-making and sustainability as a social construct. Yet, their implementation so far has rarely been addressed, even though monitoring and the use of indicator results fall far behind the number of SISs developed. This study aims at the identification of requirements for the development of and constraints to the implementation of SISs in five Asian cities of developing countries. Interviews with local key actors are held, and a qualitative content analysis is carried out. Findings include evidence on the degree of indicator implementation in the case study cities, a hexagonal model for the classification of requirements and constraints, as well as general conclusions for barriers to the use of SISs.

Keywords: sustainability indicator systems; constraints; implementation; cities; developing countries

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Introduction

Striving towards sustainable development constitutes one of the biggest challenges for Asian cities in the twenty-first century, especially in the megacities[1] of developing countries. Besides their high population growth rates and fast spatial development, they struggle with air and water pollution, a low gross domestic product and social deprivation. In the last decades, measuring development via indicators gained more and more importance (Baster 1972). Sustainability indicators (SIs) are parameters describing the state of the social, environmental and economic environment, "with a significance extending beyond that directly associated with a parameter value" (Organisation for Economic Co-operation and Development 1994, p. 9). SIs are models "implying elements of cause and effect of social norms that constitute progress, and of policy actions and outcomes" (Newton 2001, p. 17). They can be employed as single indicators as well as compiled into SI systems (SISs) or as aggregated indices. In the past two decades of the emergence of SISs, numerous requirements have been formulated for their development process. Lists of requirements typically describe technical issues for the development of SIs, SISs or indices, such as the prioritisation of indicators, the inclusion of stakeholders or the

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development of an appropriate SI programme structure (Hardi and Zdan 1997, Gahin *et al.* 2003, Mayer 2008). More recently, research shifted towards the analysis of the implementation of SIs (Gahin *et al.* 2003, Hezri 2004, McAlpine and Birnie 2005, Velázquez *et al.* 2008). Holman (2009) describes three streams of indicator research focusing on (1) the technical advancement of indicator and indicator system construction, (2) local qualitative impacts of indicator programmes (mainly soft factors) and (3) impacts on governance, decision-making and sustainability as a social construct. A fourth yet pressing topic in the field of indicator research has rarely been addressed so far: the implementation of SISs. A number of authors point at the lacking implementation of indicator programmes in comparison to the plethora of indicators developed (Pinfield 1996, Stirling 1999, Bell and Morse 2001, Hezri 2004, Garcia-Sanchez and Prado-Lorenzo 2008). For the most part, indicator programmes remain only an attempt to implement such tools, especially in cities of developing countries (Dhakal and Imura 2003, Ooi 2007). After their development (and after the kick-off funding and promotion phase are over), they vanish from the scene in many cases.

Earlier investigations on barriers to indicator implementation were conducted with different sets of parameters. Investigating implementation constraints of SIs in Malaysia, Hezri (2004, pp. 362–364) distinguishes between four issues of implementation constraints for the use of indicator systems: meta-policy issues, technical issues, communication issues and theoretical limitations. The EU-funded project PASTILLE Consortium (2002) investigated the influence on the impact of SISs in four European case studies, concluding that the influence mainly depends on relationships between policy actors and the structure of local institutions, on issues of legitimation and conflicts of interest, as well as on the role of experts and lay actors, and the ownership of the SISs. Reported deficiencies in the indicator development include the missing engagement and information of users and potential users, as well as the development of overly complex indicator frameworks (Bell and Morse 2001, Hildén and Rosenström 2008).

As findings from these previous studies draw diverging pictures of barriers to implementation, there is the need for further investigation. Our hypotheses are: (1) there are further, so far unidentified, factors limiting the implementation of indicators and (2) limitations for indicator implementation are case study-sensitive.

A review of frameworks for the analysis of implementation success of sustainability projects shows that several sets of analytical variables exist besides Hezri's and the PASTILLE approach: the *Pentagon Prism*, a taxonomy of *indicator use* and a taxonomy of *policy learning types*. The Pentagon Prism was originally developed for the analysis of infrastructure and environmental policies (Nijkamp *et al.* 1994, Button 1998, Nijkamp and Pepping 1998, Yigitcanlar *et al.* 2008). It is based on five factors: *hardware* (technical and technological elements), *software* (know-how, information and other user-based factors), *orgware* (institutional and organisational factors), *finware* (financial aspects) and *ecoware* (environmental and socio-cultural aspects of the local context). The taxonomy of use has been developed in knowledge utilisation and evaluation research since the 1970s. It includes the *instrumental*, *conceptual*, *symbolic* and *political* and, in part, *tactical* use of indicators and other information carriers (Weiss 1979, 1999, Hezri 2004, Lehtonen 2008, Yli-Viikari 2009). The taxonomy of policy learning types consists of *governmental*, *instrumental*, *social* and *political* learning (Bennett and Howlett 1992, Connor and Dovers 2004, Hezri 2004, Rametsteiner *et al.* in press). As learning is considered to be a driver for more and more successful policies (or SI programmes), the lack of learning processes might indicate a constraint to SI implementation. Our research explores the suitability of these frameworks for the classification of constraints on the implementation of SISs. More specifically, we seek to empirically investigate the implementation constraints for SISs in

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five case studies in Asian cities of developing countries. We conduct 30 expert interviews in Jakarta (Indonesia), Bangkok (Thailand), Shanghai (China), Hyderabad (India) and Ahmedabad (India) with pivotal local actors and analyse them for their degree of indicator implementation, for the experts' view on requirements for indicator design and for the specific implementation barriers. The *degree of implementation* is defined in evaluation research as "the extent of change that has occurred at some particular time toward full, appropriate use of the target innovation" (Scheirer and Rezmovic 1983, p. 601). The analysis of requirements and constraints is conducted using a qualitative content analysis (QCA). In the course of this analysis, the five dimensions of the Pentagon Prism are applied as deductive categories to the interview material. A sixth category *polware* is added to the Pentagon Prism to describe requirements and constraints named by the local actors.

Our contribution to the discussion on the constraints for implementation is: (1) to provide a typology of relevant factors and (2) to reveal specific drivers per city.

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Methods

The selection of case study cities in Asia was based on five criteria in order to achieve broad results: (1) different countries, (2) large-scale, complex cities with 5 million or more inhabitants, but with varying city scales, (3) SIS availability, (4) capital cities (national and provincial) as well as (5) emphasis on Indian cities with few implemented programmes, in order to efficiently address future SIS implementation attempts. Table 1 gives an overview on the specific characteristics of the cities surveyed with regard to our sampling criteria.

Face-to-face interviews were conducted with pivotal local actors in the case study cities from March to May 2008. Experts interviewed included agents of indicator development and application processes as not only persons with a direct involvement in the process were selected. This delimitation would have harboured the danger that potential critical voices remain unconsidered. The experts were composed of scholars of local universities ($n = 16$), government officials on national, regional, provincial and municipal levels ($n = 7$), a representative of an urban planning association ($n = 1$) as well as representatives of international and social/environmental organisations ($n = 6$).

The interviews were accomplished as semi-structured, investigative interviews in which the questions were mainly asked in an open form. Due to the somewhat precarious nature of topics such as corruption, the interviews were conducted individually, except for one case in which an expert brought a colleague along. For 16 SISs identified in the interviews, we asked interviewees about (1) the processes of indicator system development (objectives, time frame, approach, procedure and participants), (2) the systems' implementation

Table 1. Characteristics of cities surveyed referring to sampling criteria.

	Jakarta	Bangkok	Shanghai	Hyderabad	Ahmedabad
Country	Indonesia	Thailand	China	India	India
Population (in millions)	13.2[a]	6.6[a]	12.7[a]	6.1[b]	5.1[b]
Capital city	National	National	Provincial/special economic zone	Provincial	Provincial

[a]Source: Asian Development Bank (2008, p. IV).
[b]Source: United Nations Department of Economic and Social Affairs (2008, p. 189).

(point in time, parties involved, manageability, frequency of monitoring and inclusion of indicator results into decision-making) and (3) difficulties and constraints arising. While addressing possible constraints, two examples were given: the availability of data and of resources. After the experts' elaboration on constraints, they were explicitly asked whether they see any further potential difficulties. We further requested they elaborate on (4) the requirements for indicator development in their city (requirements and lessons learnt from their involvement in the development process, where appropriate) and in general.

Twenty-six interviews were recorded in the written form. Four interviews were taped as an interpreter assisted in the conversation ($n = 1$) or the interviews were less sensitive ($n = 3$). Summarising protocols were prepared with a reductive process, following the generalisation guidelines described by Mayring (2002, pp. 94–97). The experts had the opportunity to comment and to add to these summarising protocols.

The analysis of the content of the 30 interviews was conducted with a QCA (Mayring 2003). This approach aims at concentrating the interview material. Codes were developed in an inductive way through paraphrasing, generalisation to higher levels of abstraction, bundling and reductions based on pre-defined rules. We combined the inductive category development with a deductive category application of existing typologies. Inductive and deductive techniques were used in loops: each phase of generalisations and reductions in an inductive process was succeeded by a phase in which we tested existing frameworks for the application to the interview material. The application of categories then allowed for the further reduction of the material and eventually led to a new structure and thus to another applicable typology.

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Results

Degree of SIS implementation in the case study cities

Comparing the popular model for the operationalisation of sustainable development as a combination of socio-cultural, ecological, economic and management aspects (United Nations Department for Policy Coordination and Sustainable Development 1996) with the SISs investigated, the foci of the systems we studied are diverse. Not all indicator systems identified and included in this study refer explicitly to sustainable development as such a combination, but partly focus on environmental, on management or on socio-cultural issues. They also diverge in their degree of implementation. The degree of indicator implementation displayed in Table 2 refers to the respective SISs with the most advanced implementation in a case study city. The degree of implementation of indicator systems in a city shows, for example, if a regular monitoring has ever been carried out. If this is not the case, local experts are lacking this experience. For evaluations in Jakarta, one of the cities with a high degree of implementation, for instance, Frame Indicators for Socio-cultural Development DKI Jakarta, indicators in the framework of the Adipura programme and indicators for the Performance Evaluation of Local Governments in Public Works were developed (the latter two on national level). In all three cases, the development has been supported by the national or provincial government. However, the Indicators for Socio-cultural Development have not been approved "for political reasons" (Expert S3 J 2008, Interview, p. 3). Currently, monitoring is carried out with the help of the two other indicator systems. Indicator results are partly used, especially information obtained in the framework of the Adipura programme: accompanying measures, such as the establishment of community forums, offer an instrument for further improvement based on the monitoring

Table 2. Degree of SIS implementation in the case study cities.

Degree of implementation		Jakarta[a]	Bangkok[b]	Shanghai[c]	Hyderabad[d]	Ahmedabad[e]
Low	Indicator system developed	x	x	x	x	x
↕	Development supported by government	x	x	x	x	x
↕	Indicator programme approved[f]	x	x	x	x	
↕	Regular monitoring	x	x	x		
High	Use of indicator results	Partly	Partly	Partly		

[a]SISs: Adipura Program, Performance Evaluation of Local Governments in Public Works, Frame Indicators for Socio-cultural Development DKI Jakarta.
[b]SISs: Thailand Sustainable Development Indicators, Gross Domestic Happiness Index, Thailand Sustainable City Indicators, Indicators for Liveable and Sustainable Municipalities and Districts in Bangkok, Air Quality Index.
[c]SISs: Urban Sustainability Indicators on National Level, Urban Management Indicators, China's Best Resident Environment Indicators, Model City in Environmental Protection.
[d]SISs: Performance Evaluation of Municipalities, Assessing State of Governance.
[e]SISs: Urban Indicators and Performance Measurement Programme.
[f]Includes approvals on national level with voluntary participation of cities.

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results. For municipalities with top scores in national comparison, the programme demands the achievement of higher scores in the following evaluation process. Evaluation results thus form the basis for improvement.

Typology of relevant factors

The *Pentagon Prism* developed by Nijkamp *et al.* (1994) and Nijkamp and Pepping (1998) is applied to the categorisation of requirements of successful indicators and hindering factors for their implementation mentioned by the actors. It is, as described earlier, based on five decisive factors for the success of policies: *hardware*, *software*, *orgware*, *finware* and *ecoware*.

The loops with inductive category development and deductive category application show that this model describes requirements and constraints well but not comprehensively. The inductive analysis of the experts' statements shows the necessity to add the sixth category *polware*, dealing with political and policy-making factors to the typology of requirements and constraints (Figure 1). The literature supports the empirical finding: SIs are seen as being embedded in the context of political activities (Eckerberg and Mineur 2003, Journel *et al.* 2003), and a failing implementation is often attributed to

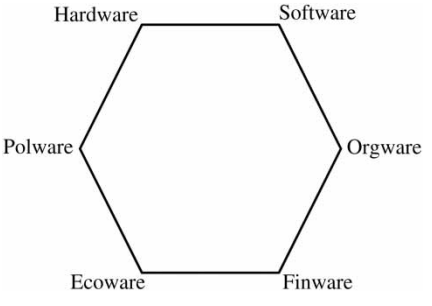

Figure 1. Hexagonal typology for the analysis of requirements and constraints of indicator development/implementation.

governmental reluctance or inability (Hezri 2004, p. 362). Further specifying the five dimensions of the Pentagon Prism for application in the analysis of SISs in Asian cities, *hardware* covers the indicator system itself and additional technical factors. The *software* of SIS comprises factors concerning both direct users (monitoring staff and associated authorities) and indirect users (external stakeholders, e.g. associations, the economic sector and the public). The aspect *orgware* includes institutional and process-related requirements and constraints, such as (lacking) push and pull factors for the implementation of the indicator systems. *Finware* describes financial and efficiency factors, i.e. financial resources for the evaluation process. *Ecoware* maps environmental and socio-cultural aspects relevant to the success or failure of a certain set-up of monitoring, i.e. the cultural background of a city.

Requirements for SIS development

The requirements for SIS development mentioned by the pivotal local actors describe necessary conditions for the successful development of SIs. The local actors listed requirements both for a development of successful indicator systems in general and for their respective city. Yet, only some specific needs for the individual megacities were communicated, mainly dealing with hardware and ecoware components. Table 3 gives an overview on the requirements for SIS development organised into the hexagonal typology developed.

In the field of *hardware*, the requirements mentioned constitute technical factors typically listed in the literature. The local actors argued for a few single indicators embedded in practical tools, for a combination of different types of indicators (such as quantitative and qualitative indicators, outcome and output indicators), a (methodological) stringency in indicator construction and an analysis of interlinkages between indicators. The experts further put emphasis on the challenge to make use of appropriate data. Depending on the local system, they claim a more detailed statistical system, an improvement of the project-related data collection procedure and especially the system-independent data verification. Two further aspects highlighted concern the decisions on index construction and on the use of local or global indicators. Whereas two experts explicitly recommend the construction of indices, one expert argues against indices as they entail a higher potential of misinterpretation. In addition, advantages of local and common indicators in a geographical area were discussed without achieving a generally applicable recommendation. A special subject raised is the proposition of "observatory indicators" by a government official. The highly subjective observation of problem areas seems to be a pragmatic substitute for missing ulterior indicators. Overall, the experts followed in their argumentation the state of research in the field of indicator and indicator system development. The technical know-how for indicator development thus shows to be available in the case study cities, and it does not seem to constitute a constraint for indicator implementation.

The software factors the experts mentioned include aspects concerning the information and communication needs of different actors that can be determined in the design phase: SISs should be easy to communicate and easy to understand. The experts further claim an eagerness from different urban stakeholders to be involved.

In the field of *orgware*, the local actors highlight aspects in the process of the indicator development (commissioning of indicators by the government and making information public to citizens), as well as the importance of considering the governmental structures. The latter is considered of special importance in megacities, in which administrative and governmental structures are highly complex (Expert S6 B 2008, Interview, p. 2).

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Table 3. Requirements for the development of sound SISs as mentioned by the experts.

Type of requirement	Aspect
Hardware	Careful, transparent construction Few key indicators Simple indicators Decision on index construction[a] Types of indicators: quantitative, qualitative, outcome, output, observatory Comparative indicators and benchmarks Avoid "alternative" indicators Analysis of cross-linkages Broad coverage of indicator systems Decision on locally *vs*. globally[b] Appropriate data (depending on local conditions: detailed statistics, data verification system, improvement of data collection) Practical tools
Software	Easy to communicate Easy to understand Eagerness of citizens to be involved
Orgware	Commissioning of indicators by government Consideration of governmental structures Information of citizens
Finware	Budget
Polware	Legal framework Agreement on indicators Policy-oriented tools Development of indicators decision-makers are interested in
Ecoware	Consideration of social, cultural and ecological environment Decision on awarding process Decision on accompanying measures Decision if process compulsory/voluntary Decision on owning entity[c]

[a]Two experts recommend the construction of indices, one expert discourages from the use of indices.
[b]The experts discussed advantages of local indicators *vs*. benefits of common indicators within a geographical area.
[c]When the development process of indicators starts, usually this decision has already been made. Experts advocate different owning entities from citizens to national governments.

The provision of a financial budget is mentioned by the experts as a necessity for indicator development (*finware*). As an expert involved in indicator development and application processes puts it: "implemented is just what is funded" (Expert S2 J 2008, Interview, p. 1).

In the field of *polware*, the local actors consider political support for SIS development and assessment processes essential – both in the form of a legal framework and in the form of personal interest of decision-makers.

By nature of their definition, the elements enumerated by experts in the dimension *ecoware* are highly dependent on the specific situations in the case study cities. Besides the social, these include the cultural and the built environment, decisions that need to be made regarding the set-up and the organisation of a future assessment process, such as the decisions whether an award should be offered and accompanying measures be taken, whether the assessment should be carried out on a voluntary or compulsory basis and which would be the owning entity.

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Constraints to the implementation

Comments on constraints to indicator implementation were mainly case study-specific. When talking about the barriers to implementation, experts often referred to concrete situations or to specific institutions.

Generally, the actors see the success of indicator implementation strongly depending on good governance and leadership. As one expert stated: "It's beyond the indicators: if indicators [. . .] fall in the hands of good leaders, it can be more than that" (Expert SE1 J 2008, Interview, p. 3). In this case, SISs have an impact and do not only serve for reporting. In four of the five case study cities (Ahmedabad, Bangkok, Hyderabad and Jakarta), the lack of implementation of all kinds of policies and programmes has been named as the major challenge in planning and management, not the development of instruments themselves.

In classifying the constraints according to the hexagonal typology of crucial factors, we see that a clear distinction between aspects is somewhat difficult as different aspects are interwoven (especially concerning ecoware aspects). Table 4 gives an overview on the constraints per case study city.

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Table 4. Constraints for the implementation of indicators per city as mentioned by the experts.

Type of constraint	Aspect	City
Hardware	Assembling difficult	General
	Complexity	General
	Data unavailable	General
	Lack of database	Jakarta
Software	Little awareness	Bangkok, Jakarta
	Fear	General
	Little recognition of importance	Bangkok, Jakarta
	Intuition/feeling instead of indicators	Hyderabad, Shanghai
	Lack of social consciousness/sensitivity	Ahmedabad, Hyderabad
	Limited capability	Shanghai
	Proactivity missing	Bangkok
	No sense of ownership	Bangkok
Orgware	Speed of functioning	Bangkok, Hyderabad, Shanghai
	Size of the city	Bangkok
	Limited capacity	Ahmedabad, Bangkok, Jakarta
	Administrative structures	Bangkok
	Voluntary assessment	Bangkok
Finware	Limited budget	Bangkok, Jakarta, Shanghai[a]
	Difficult budget system	Bangkok, Jakarta
Polware	Responsive decision-making	Ahmedabad, Hyderabad
	Market-oriented activities	Bangkok, Hyderabad
	Priority on image construction	Hyderabad
	Focus on prestige projects	Hyderabad
	Lack of political will[b]	Ahmedabad, Bangkok, Hyderabad
Ecoware	Corruption	Hyderabad
	Corruption in terms of time	Bangkok
	Lacking participation	Bangkok, Jakarta
	Lacking pressure lobby from the civil society	Hyderabad

[a]In Ahmedabad, the budget is explicitly not considered a constraint.
[b]Political will and the willingness of an individual (software) can hardly been distinguished. In this study, we only refer to political will as it constitutes a system-based (and thus more influential) constraint.

Obstacles for the implementation of SISs in the area of *hardware* have been considered much less case study-sensitive than in other fields. The local actors name the breaking down of the complex concept of sustainability and the complexity of megacities as challenges. Further, the location and/or the collection of appropriate data are regarded as a constraint.

Software factors form a significant group of implementation barriers. The experts enumerated various aspects concerning this type of constraint, reaching from passivity and lacking awareness to limited capability of users and potential users. Several interviewees pointed out that personal sensations, such as fear and intuition, often hinder (and replace, respectively) the actual use of SISs. Further constraints identified are the lacking recognition of SISs' importance, the lacking sense of ownership among users, and even a lacking sensitivity is ascribed to users. Software factors restrict the use of SISs in all cities surveyed. Yet, especially in the case of Bangkok, a lacking involvement of users (ownership, awareness, recognition and proactivity) has been reported. Bangkok is the city with the broadest experience in indicator system development and application; the numerous restraining software factors mentioned might be due to the excessive experiences of interviewees with SISs. Capability was mentioned as a hindering factor in only the case of Shanghai.

Aspects named in the field of *orgware* include characteristics of the megacities themselves (speed of functioning and size of the city), of their administration (structures and capacity) and of specific SISs (voluntary assessment). Concerning the distribution of restraining aspects, the speed of functioning of the cities and, partly associated with that, the limited capacity of administrations seem to play a significant role in almost all cities surveyed. The other aspects have only been mentioned for the case of Bangkok, where again the excessive SIS experience might play a role.

Budget or the budget system (*finware*) is considered a constraint in all case study cities, except for Hyderabad (this aspect has not been touched upon in the interviews) and Ahmedabad. In the case of Ahmedabad, budget is explicitly considered not to constitute an obstacle. Yet, Ahmedabad shows the lowest GDP *per capita* among the five cities surveyed, which might lead to the assumption that finware is strongly depending on political will.

A key challenge for implementation in the field of *polware* in almost all case study cities is, according to the experts, indeed the reported lack of political will in combination with missing individual willingness of government officials. Further constraints observed by the local actors focus on various governmental priorities (market orientation of activities, image construction and prestige projects), which do not include the construction of and the assessment via SISs. In addition, a rather responsive style of decision-making in the Indian cities was reported as a hindering factor. Polware has especially been mentioned as an issue in Hyderabad, where to date no long-term implementation of SIs has taken place.

In the field of *ecoware*, corruption (also in terms of time) and lacking activity/influence of the civil society are considered as constraining factors by experts. Participation and a pressure lobby from the civil society have been requested for an Indian case (Hyderabad) and for the Southeast Asian cities. In Shanghai, where governance is organised on a more authoritarian basis, this claim has not been expressed by experts. Corruption has only been mentioned for the cases of Bangkok and Hyderabad. However, it is believed that corruption plays a role in other case study cities, and the Corruption Perceptions Index 2009 shows similar scores for all four countries surveyed (Transparency International 2009).

Discussion and conclusions

Generally, SIS programmes in Asian megacities of developing countries are only partly put into action, and their implementation processes underlie specific constraints. However, the

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degree of indicator implementation varies in the five cities we surveyed. Whereas numerous SISs have been developed with the support of the local government in all cities, indicator programmes have not been approved in all of them. Regular monitoring takes place in Jakarta, Bangkok and Shanghai, cities of a larger political importance. In the experts' view, the SISs' results are only used to a limited extent for political decision-making.

Our study shows that requirements for SIS development and constraints to their implementation can be organised into a hexagonal framework distinguishing between *hardware*, *software*, *orgware*, *finware*, *polware* and *ecoware*. Previous literature on barriers to indicator implementation supports our empirical results in the political (PASTILLE Consortium 2002, Hezri 2004) and technical areas (Hezri 2004). While the studies also touch further issues within our framework, the present results show to be broader in many cases. For example, the issue of SIS ownership identified by PASTILLE Consortium (2002) is embedded in our framework in software factors.

Furthermore, neither requirements for SIS development nor constraints for their implementation are identical in different cities, which confirm our theoretical assumptions. As political, administrative and cultural settings, the stage of development and the city size of the case studies vary, requirements and constraints diverge. Given the numerous international SISs applied to different contexts in a uniform way, this finding needs to be emphasised. Especially the analytical dimensions hardware and ecoware show that SIS developments need to consider the specific local context in a sound way. Barriers to implementation, in contrast, can often be found in software, orgware and polware constraints. However, the study also shows that requirements of SIS development are less case study-sensitive than actual implementation constraints. Most requirements have been mentioned by the experts for the generic case, and necessary decisions are uniform. Only the decisions themselves (e.g. which type of data?, which accompanying measures?) are specific.

Finally, the research identifies a number of constraints to SIS implementation that have not been reported in the literature so far. These include unperceptive, passive and fearful users, a lack of will and focus on visible short-term projects on a political level, corruption and a missing pressure lobby from the civil society. Structural issues, such as the complexity and speed of functioning as well as a missing budget for the implementation of SISs, are directly linked to megacities in developing countries.

However, beyond the aspects we have identified, we assume that additional factors may also have a significant role to play. Dhakal and Imura (2003, p. 117) conclude from their investigation of major international indicator initiatives that in an environment of non-transparent decision-making and political commitment, "a political leadership may hesitate to use the indicator system in policy making as it has the potential to show their inefficiency more visibly". This non-use based on tactical reasons may, for example, play a role as a hindering political factor in addition to the concrete constraints found in this research.

As the study draws on 30 expert interviews, it is necessary to take into consideration that the actors' responses are a form of subjectively biased knowledge. By combining indicator document reviews, interviews and a review of relevant literature, we have attempted to underpin the results given by the varied range of experts interviewed in this study. It is believed that especially software and finware factors have a more general effect on hindering the implementation of indicators than the study suggests. If this is true for the five heterogeneous case study megacities in Asian developing countries, it is most likely possible to extend the findings to other megacities with the same characteristics. A comparison with the results from previous studies in the Western context (Bell and Morse 2001, PASTILLE Consortium 2002, Hildén and Rosenström 2008) shows that

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our findings are applicable, to a limited extent, to cities in industrialised countries. Only hardware, software and institutional deficiencies, as well as the lacking civil participation, overlap partially with our findings. Future research should thus include surveys covering more actors to reach a higher saturation of data and systematic inquiries based on the requirement and constraint aspects present.

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Note

1. A megacity is characterised by its complexity, a high population density and, in terms of size, by its population of more than 5 million, more than 8 million or more than 10 million inhabitants, depending on the definition (Kraas 2007, p. 82). Megacities in developing countries and transitional economies are characterised by a *per capita* city GDP under $10,000, high population growth rates, a relatively young population, informal settlements, only partially effective pollution control mechanisms, recurrent disasters and high land values in areas with infrastructure (Asian Development Bank 1996, pp. 30–33).

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