Spat. Inf. Res. (2017) 25:605–613
DOI 10.1007/s41324-017-0125-3

Evaluating land-use plan using conformance-based approach in Adama city, Ethiopia

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Received: 21 March 2017 / Revised: 20 July 2017 / Accepted: 22 July 2017 / Published online: 1 August 2017

Abstract Urban land-use plan is regarded as a useful tool to achieve urban sustainable development. However, presently it is unclear that how well the Plan is being implemented and major factors contribute to the variation of its implementation in Adama city, Ethiopia. This research examines the extent to which Land-use plan of Adama city functioned from 2004 to 2014 has guided and controlled all spatial developments during planning period by measuring the degree to which actual land-use outcomes over a 10-year period conform to the Plan intention. Land-uses of the City as of 2004 and 2014 are mapped; conforming, nonconforming, and unfulfilled developments are identified through spatial overlay analysis in geographic information system environment; effectiveness of boundary containment and proposed land sufficiency are explored. The findings demonstrate that although the Plan proposed reasonable area, it has met difficulties to control and guide new spatial developments of housing land-uses followed by social services and total urban growth. The limitation is due to combined result of geographic variables, absence of regular monitoring and evaluation, lack of commitment, and political leadership influence. The study would support sustainable spatial policy and direction of spatial development with respect to sustainable urban environment.

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Keywords Land use planning · Urban planning · Conformance based approach · GIS · Plan evaluation

1 Introduction

The fundamental goal of urban land-use plan is to ensure sustainable development of urban areas. Through effective implementation it controls urban expansion within the planned boundary, conserves ecologically sensitive areas, ensures effective use of existing resources and balanced development, and supports smart growth. Understanding of the level of plan implementation supports the plans' effectiveness and success, consenting for the enhancement of plans and the planning process in subsequent planning [1, 2]. Therefore, evaluating the implementation of land-use plans in urban areas is a key focus in sustainable planning, which receives more and more attention of scholars [3].

Evaluation of plan implementation has been conducted for different purposes priori, on-going monitoring and ex post facto [4–7]. However, while "in the final analysis, outcome evaluation is the true test of development management effectiveness" [8] ex post facto attempts to evaluate the outcomes of land-use plan are rare [9]. Moreover, despite its importance, plans are continuously redone or updated without regard to the implementation status of the originally prepared plan. The lack of information with regard to the degree to which plans are implemented and the determinants of effective implementation have hindered planners from making better plans [10]. Moreover, plan implementation is a rather complex process that can be influenced by various factors, and suggests the need for more researches to develop a sufficient understanding [11].

In Ethiopia, till recent years, evaluation of urban land-use plan implementation is uncommon with exception [12, 13]. This gap presents a key avenue for this study. In particular, according to Adama city master plan revision project report by National Regional State of Oromia dated June 2004, land-use plans for Adama city have been prepared and implemented since 1937, and updated for four planning periods in 1959, 1971, 1995, and 2004. The latest plan updated in 2004 was functional from 2004 to 2014 and denoted by LUP04 in this study. The revision project to update LUP04 is currently ongoing. However, presently how well the Plan is implemented after plan adoption and major factors that contributed to the variation of its implementation remaind unclear. Given the potential benefits of understanding the level of the original plan implementation, it is important to evaluate the extent to which LUP04 has guided and controlled the spatial development of the City during the planning period and to shed light on the reasons that led to deviation.

The studies have been conducted using the two acknowledged theories [3]. They are conformance based approach, which highlights the conformity between physical development and plan's intention; and performance based approach, which focuses on how the plan is consulted in decision making process. Hence selection between the two evaluation approaches depends on ones understanding of spatial planning and the type of plan under study. LUP04 is essentially a material-oriented blueprint plan with a clear envisaged end-state. The time element in the Plan is limited to specific period. The effect of all the arrangements set in the Plan starts when the Plan is approved, and terminates when the planning period comes to an end. Therefore, effectiveness of the Plan implementation should be measured by the level of conformity between actual land-use outcomes and plan proposal.

In this study, morphological conformity was assessed by comparing physical development with plan's prescription by using land-use land-cover as of 2004, 2014, and map of proposed land-use plan. Level of implementation success was explored through two indicators: boundary containment ratio (BCR) and boundary sufficiency ratio (BSR). Finally, factors contributing to variation of the Plan implementation were highlighted.

2 Literature review

Planning evaluation contributes to the accountability of, and trust in, public managers and institutions, and guide improvements in plans and practices [14]. Moreover, understanding the degree to which plans are implemented and the determinants of effective implementation benefit planners for making better plans. Planning evaluation can be conducted for different purposes as a priori or ex ante evaluation [4] on-going monitoring or formative evaluation [5] and ex post facto or retrospective evaluation [6, 7]. While "in the final analysis, outcome evaluation is the true test of management effectiveness" [8]. Ex post facto attempts to evaluate the outcomes of land-use planning are rare [9]. Most ex post studies evaluate planning outputs (that is, policies, programmers, projects, regulations) rather than outcomes [5], and most show how scarce ex post outcome evaluations are in planning practice rather than evaluate implementation (exceptions include [15–18].

Since evaluation is concerned with the "success" of plans, the theories used for plan evaluation should be able to identify how successful plans are. In order to achieve a proper evaluation for different plans, evaluation theories need to be selected based on the nature of plans. According to the Dutch school of plan evaluation [19, 20], urban plans can be categorized into project-oriented plans and strategic plans. Projected-oriented plans refer to traditional plans which mostly provide blueprints of the designated end-state of the physical environment. On the other hand, strategic plans deal with the coordination of diverse actors. Apparently, project-oriented plans are more physical and material while strategic plans are concerned with decisions and more characterized as a dynamic process.

There exists a divergence of approaches proposed in a number of studies to evaluate urban planning implementation and they are generally categorized into conformance-based approach and performance-based approach. Planning conformance refers to the conformity between plan and actual development. This theory follows a technocratic view and emphasizes the role of planning as a rational tool to draw a blueprint. Specifically, it assumes that once a plan is adopted, a definite image of the future is confirmed. Thus, the plan evaluation can be undertaken by identifying how closely plan outcomes conform to plan prescriptions [3]. Hence, conformance-based evaluation means judging the success or failure of a plan by measuring the conformance degree between the actual physical development and the previously designed plan proposals. A high conformance degree indicates the implementation is well achieved and vice versa. Performance-based approach focuses on whether and how the plan is consulted in subsequent planning process. It insists that planning is a process of decision making under conditions of uncertainty, as long as the outcomes are beneficial, departures from previous plans may be considered acceptable. It is well suited to evaluate comprehensive and strategic plans [21].

To the support of conformance based, a number of studies have provided insight into the theme of urban plan implementation evaluation by measuring the conformity between physical developments and plans' intention [10].

The studies indicate that plan implementation is complex process that was influenced by various factors, and suggests the need for more researches to develop a sufficient understanding.

Identifying the factors affecting implementation is as important as plan implementation. Influential factors of land-use plan implementation mentioned in the relevant literature [12, 13, 22–26] can be summarized into three: plan quality, implementation quality and contextual characteristics. Plan quality encapsulates elements in the plan formulation process, such as the suitability of the planning techniques, involvement of different stakeholders and so on. Implementation quality refers to elements in the implementation process, like plan monitoring, evaluation, commitment, supportive regulations and legislations, etc. These two categories cover factors that are directly related to plans. Contextual characteristics mainly contain external factors that influence plan implementation like policy, environment, geography, political influence, and socioeconomic changes.

3 Study area, materials and methods

Adama city has various advantages that make it an appropriate selection for this study. Among these, end of planning period of the latest land-use plan for the City is more recent which can provide important information for currently ongoing revision project of the Plan. In addition the study area is located in a place where it is easy to find data to map, verify, and interpretation of the findings.

Adama city is one of fast growing cities in Ethiopia. It stretches between 8°26′15″N to 8°37′00″N latitude and 39°12′15″E to 39°19′45″E longitude (Fig. 1) and occupies 134.11 sq. km. The good geographical location nearest to the capital city Addis Ababa and favorable climatic situations of Adama have contributed to the rapid expansion of the City as commercial, industrial, residential and recreational center since its establishment in 1916. Economic potential and prospective development of the Awash Valley is also among the major factors that contributed to the growth and development of the City and the neighboring region at large. On top of this, in August 2000, Adama was given a new status and became the seat of the National Regional State and Capital city of Oromia, the largest Regional State in Ethiopia. This contributed to a significant impact on the rapid development of the City. Total population of the City in 2016 is 356, 304 [27], which was 127, 842 in 2004 when LUP04 came into effect, as it is reported in master plan revision project.

The City administrative area currently comprises fourteen Kebeles. Kebele refers to the lowest level of city administration among which six Kebeles are located at the

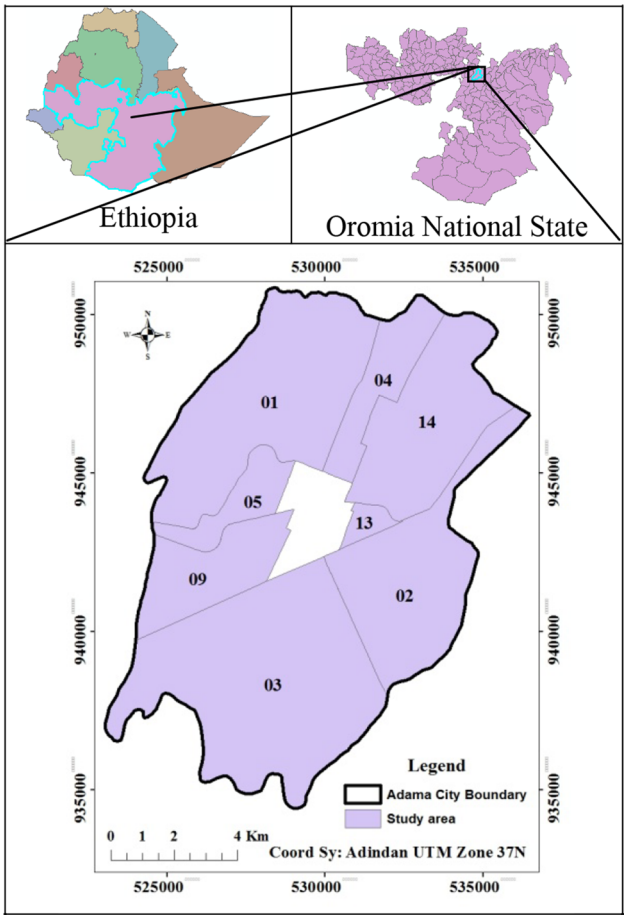

Fig. 1 Location map of the study area

central part occupying 5.8 sq. km. The area was covered with dense mixed built up during LUP04 preparation. The rest eight Kebeles are located at the periphery occupying 127.9 sq. km. Even though the Plan proposal covers the whole Kebeles, new expansions were mainly proposed in periphery Kebeles. Hence, Kebeles at periphery are selected for this research, as they are deemed to demonstrate new developments under LUP04 control during planning period.

According to Adama city master plan revision project, synthesized structural plan report, the LUP04 is focused on the following six framing elements that have direct and strong impact on the development of the City.

- Total land development crucially showing the direction of urban growth and reflecting spatial organizations according to the economic situation and policies.
- Housing expansion area to accommodate fast growing population in the City, mainly at periphery areas focusing to the north and south parts.
- Proposing social services in such a way that their location and spatial distribution ensure balanced development and provide uniform services.

- Manufacturing and storage developments should decentralize activities and minimize the need for transportation, and aiming to relocate existing manufacturing and warehouses that create disturbance at the inner city.
- Infrastructure developments as important strategy to improve living environment and enhance the City competitiveness, and to support the future urban development through establishing a transport framework.
- Protecting environment and green spaces through proposal of open spaces: formal green, informal green, farmland, and ground water protection area as an important strategy to prevent unplanned urban expansion and to protect natural setup of the City.

Hence, the study selected urban growth, housing, social services, manufacturing and storage, road network, and environment and green space since they are significant variables to demonstrate the conformity of actual land-use outcome with plan intention. Each variable was assessed through morphological conformity using spatial distribution, and quantitative conformity using spatial extent.

ArcGIS 10.1 software was used to interpret and process data extracted from, digital orthophoto with 15 cm spatial resolution acquired in February 2014, JPG documents of land-use map of June 2004, scale of 1:5000 and map of plan proposal following the procedure detailed in Fig. 2.

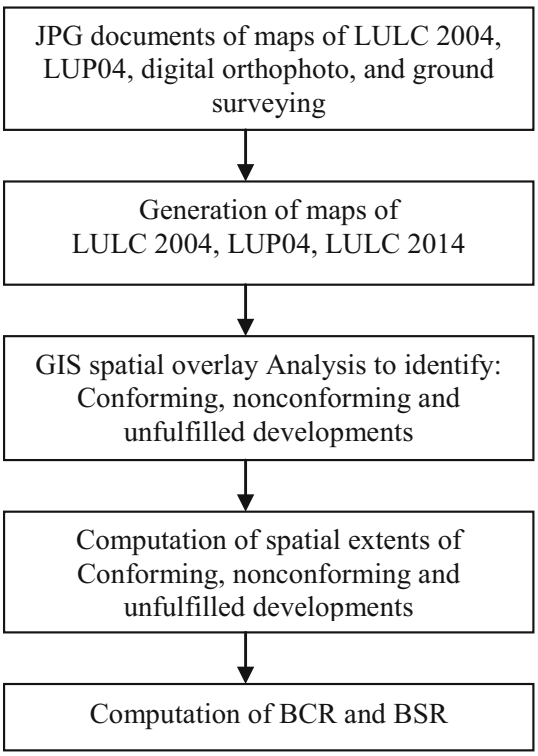

Fig. 2 Flowchart of data analysis procedure

First, the maps were georeferenced using coordinates of intersections of easting and northing gridlines, with maximum root mean square error of 0.07 m of control points. Physical land-use as of 2004 (PLU04) and proposed land-use by LUP04 were digitized from maps to common Geodatabase with Universal Transverse Mercator Projection system (Adindan UTM Zone 37 N). Physical developments as of 2014, was digitized from digital orthophoto having 15 cm spatial resolution acquired in 2014 and ground surveying using handheld GPS. Next, topology was created and applied for the datasets and digitization errors were corrected. Handheld GPS was used to verify and guide the collection of information of actual function of a plot of land (land-use) as of 2014, which was collected using simple questionnaire comprising of both open and close ended questions supported by interview questions to trace back information of land-use as of 2014. The information was entered into attribute table of features in ArcGIS.

Second, proposed land-uses were reclassified into two classes: Constructible and construction forbidden areas (Table 1) to generate urban construction control boundary (UCCB). In reclassification process constructible land-uses were assigned 1 and for construction forbidden areas 0 was assigned. The delimitation of the UCCB provides reasonable basis for studying the spatial growth boundary of the City, defining the construction land scale and identifying the scope of construction lands.

Morphological conformity was examined through spatial overlay analysis of actual land-use outcomes as of 2014, map of proposed variables in the Plan and land-use as of 2004. In this regard, for every variable, three indices were defined:

- *Conforming* if the use of land as of 2014 is consistent with proposed land-use.
- *Unfulfillment* if the use of a piece of land as of 2004 and 2014 are consistent, but different from plan proposal for the variable, then the Plan is not yet implemented. But it might or might not be implemented in the future.
- *Nonconforming* if actual land-use as of 2014 is different from the use as of 2004 and plan proposal.

Quantitative conformity was assessed to evaluate the level of spatial extents of actual physical developments of each variable conform to the extent proposed by the Plan. It was examined using two basic indicators: boundary containment ratio (BCR) and Boundary Sufficiency Ratio (BSR) initially developed by Han [28]. BCR was used to identify to what extent actual land-use outcomes as of 2014 deviate from intended land-use in the Plan. It is measured by the ratio of "area of nonconforming developments to area of conforming development". The higher

Table 1 Reclassification of proposed land-use catagories into "two area" from LUP04

Proposed land-use category in LUP04	New class
Centers and markets, Housing expansion, Mixed land-use, Social service, Health service, General service, Manufacturing and Storage, Government office, and Transport	Constructible area
Children play ground (formal green), Informal green, farm land, ground water protection zone, Horticulture	Construction forbidden area

values of BCR indicate limited implementation and vice versa.

$$\mathrm{BCR_i} = \frac{(\mathrm{Nonconforming\ \ area})_i}{(\mathrm{Conforming})_i}$$

implies

$$\begin{array}{ll} \mathrm{BCR} = 0, & \text{complete effectiveness} \\ 0 < BCR < 1, & \text{complete effectiveness} \\ \mathrm{BCR} \geq 1, & \text{complete failure} \end{array}$$

BSR was used to define the total possible increase of developed land for the variable. In this case, in order to achieve effective containment, the area of actual total development of the variable should not be more than the area proposed for the variable. It was measured by the ratio of "total area of actual developments to area of proposed land in LUP04".

$$\mathrm{BSR_i} = \frac{(\mathrm{Total\ development})_i}{(\mathrm{Proposed\ area})_i}$$

implies

- BSR $\leq$ 1, planned area is sufficient to accommodate the development
- BSR $>$ 1, planned area is insufficient to accommodate the developments.

Field investigation was carried out for the purpose of collecting further detailed information of nonconforming developments. On top of this, interviews were undertaken with residents and planners working in the City Administration to pinpoint the substantive reasons that led to deviation between intended and actual developments.

4 Results and discussion

The results depicted in Fig. 3 illustrate spatial distribution of conforming, nonconforming and unfulfilled developments of six variables (total growth, housing, social service, manufacturing and storage, environment and green, and road network) in Adama city from 2004 to 2014 as compared to LUP04.

Overall, the majority of developments have followed a plan; however, there are nonconforming developments occurring outside of proposed locations mainly at western and eastern parts of the City. In contrary, large areas within UCCB that are located at northern and southern parts are waiting for developments.

Spatial location of nonconforming developments varies between variables. For instance, most of nonconforming housing developments are outside of UCCB at western and eastern parts along the main road and intersection with expressway (Fig. 3a). Majority of them are residential developments and high-rise buildings. Other leapfrogging developments identified in northwest part are informal and illegal developments that may occurred due to lack of regular monitoring. Social services and manufacturing and storage developments are distributed within UCCB (Fig. 3d, e). Most of these developments are warehouses existed prior to LUP04 preparation and proposed to be removed gradually during planning period. This is important information which can help planners to recognize where there is significant deviation from original plan intention, and may adversely influence urban environments.

Undeveloped areas within UCCB are mainly perceived in northern and southern parts (Fig. 3a). In addition to unfulfilled road development, low level of urban services such as water supply, electricity etc.… in these areas might have hindered the developments. This should be considered in keeping a plan on track and ensuring effective implementation of unfulfilled areas.

Spatial analysis of accordance, deviation, and unfulfilled developments and computed value of boundary sufficiency ratio for the variables are summarized in Table 2. Except road network, significant nonconforming developments are identified in other variables. On the other hand the spatial extents of unfulfilled developments are apparently greater than that of nonconforming, which shows the proposed spatial extent could accommodate the new developments if it is measured by actual development density. For instance, nonconforming housing developments are about half of that of unfulfilled area. In addition, all developments outside UCCB are green frame encroachments covering

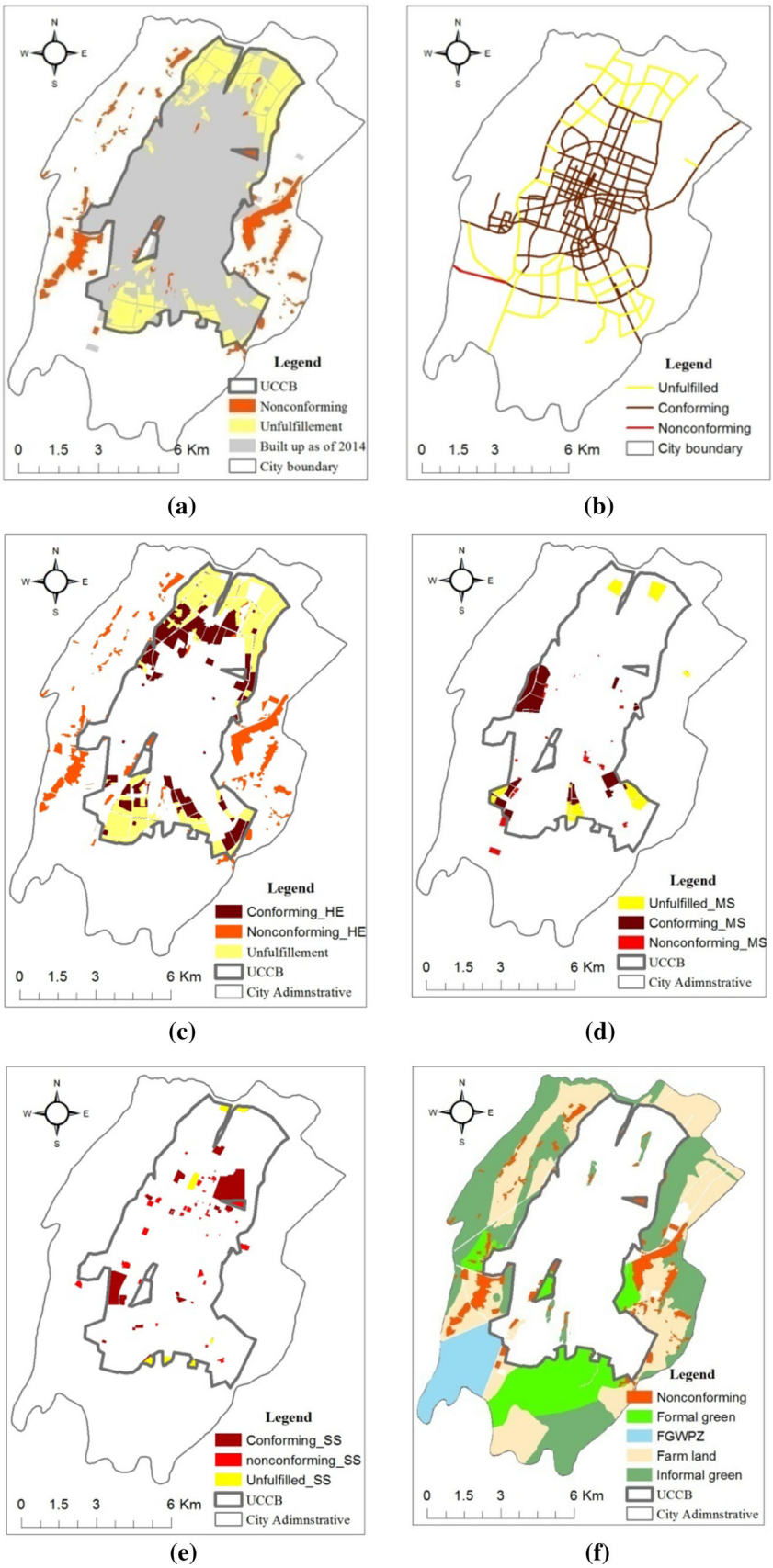

Fig. 3 Spatial distribution of accordance, deviation and unfulfilled developments in Adama city as of 2014 **a** total growth, **b** road network, **c** housing, **d** manufacturing and storage, **e** social service, **f** environment and green frame

Table 2 Spatial extent of conforming, nonconforming, unfulfilled developments as of 2014 in Adama city as compared to LUP04

Variable	Area (ha)			BSR
	Conforming	Non- conforming	Unfulfilled	
Urban growth	1615	570	1124	0.2
Env't and green	7317	570[a]	–	–
Housing	657	512	1019	0.7
Social service	263	90	73	1.0
Industry	277	51	181	0.7
Road network	128	2.6[b]	64	0.7

[a] Misused

[b] Kilometer

570 ha. Relatively road development has followed the proposal except 2.65 km which is due to modification of expressway alignment. Furthermore, computed boundary sufficiency ratio of all variables is within a limit.

Figure 4 illustrates the variation in effectiveness of containment capability of the Plan between the variables measured by boundary containment ratio. Overall, the Plan has met difficulties to guide and control spatial developments of all developments. More specifically, limitation in housing developments is more significant followed by total growth and social service developments whereas road developments have effectively followed the proposal.

To sum up, the findings demonstrate that the level of conformity is acceptable when measured by size or quantity. In other words, the total area of increased developed land during planning period remains in the limit of the land-use quota proposed by the Plan. However, the level of conformity is low when measured in terms of morphology indicating limitation of the Plan in controlling spatial location of new developments except that of road development. The limitation is high in housing developments followed by social service and urban growth while it is relatively low in manufacturing and storage, environment and green frame. Based on these evidences, it is possible to conclude that LUP04 has met difficulties to play its role in guiding and controlling spatial development of Adama city from 2004 to 2014. The limitation may be related to the following four potential factors.

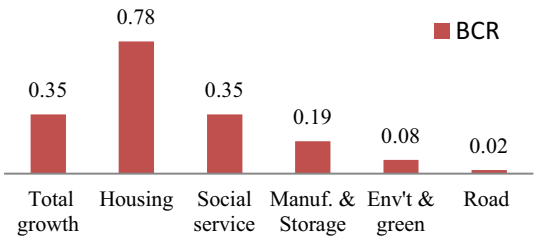

Fig. 4 Variation of containment capability of the Plan between the variables

First, proximity to likely public infrastructures and major transportation corridors significantly affected the degree of implementation. As noted in different study, transportation routes are responsible for linear branch developments of urban area [29, 30], and they are commonly considered in modeling and forecasting urban sprawl [31]. In this study, most of nonconforming developments occurred outside of UCCB are close to major road and expressway passing through the planning area. In addition, these areas are characterized by better infrastructure development and urban services. In the contrary, lack of these variables at extreme northern and southern parts of the City has retarded the development of housing, social services, and manufacturing and storage.

Second, limitation of a plan in curbing urban expansion is an indicator of lack of plan implementation and monitoring [32]. Similarly it might be another important reason for the deviation because technically, through regular monitoring and evaluation of implementation of the Plan using geospatial technologies such as GIS and remote sensing, it would be possible to identify unplanned developments and take measures to stop the construction in a timely manner. In addition to this, despite the developments outreached the UCCB, proposed area had not been fully urbanized. Moreover, most of reserved land for new developments at extreme northern and southern parts of the City is already supplied to developers before 3 years of end of planning period. However, either it was not developed within the time limit given by City Administration which is usually 6 months or has not transferred to potential developers in timely manner and ensure balanced development in planning period. These show absence of close monitoring and evaluation to support effective implementation.

Third, lack of commitment of officials results poor implementation of land-use plan [12, 23]. Likewise, it is another potential reason that affected effective implementation of the Plan because illegal and informal developments existed in 2004 were not considered during LUP04

preparation, and proposed to be removed gradually in planning period. However, in practice, the City Administration has not removed many of these developments. Instead, spatial expansion occurred around them; some of them are recognized. This is why the majority of illegal developments and most of residential and warehouses as of 2004 existed in 2014.

Fourth, unsupported political leadership is the most essential reason that leads to deviation between plan and outcomes [22, 32]. In Adama city, it is perhaps another reason that led to limited implementation of the Plan. LUP04 is mainly a government-led plan, thus, the extent of support from regional government will largely decide the extent of implementation success of the Plan. In Adama, socio-political acceptance and economic development are given the first priority; hence, in most cases the City Administration chooses to secure political acceptance and support developments rather than control. With this aim, political leaders in the City Administration, Mayor and its advisory team (cabinet) would place their primary focus on economic development and political security since both are the principal criterion when regional government assesses their political achievements. Hence, the success of investments in Adama made the City Administration believe that attracting developers through land supply was an effective way to maintain a rapid economic growth. Therefore, when development projects come to Adama, the City Administration and regional government would satisfy the site selection proposed by developers as much as possible even areas outside of UCCB were chosen. Especially ones with large economic added-value showed their interests in the City, investors were almost free to select any sites they needed regardless of the limit of urban growth. In order to retain the investment, the City Administration ultimately accepts their applications. This explains why nonconforming land developments occurred outside of UCCB at the western part of the City is high standard hotels. Hence, political leadership in Adama has not created a supporting implementation environment for the Plan.

5 Conclusion

This research evaluates the level of Adama city land-use plan implementation by measuring the conformity between actual land-use and plan proposal. The value of the study can be explained in different ways. First, morphological conformity assessment provides spatial distribution of conforming, nonconforming, and unfulfilled developments. Spatial extent of nonconforming developments are total urban growth, 570 ha; housing, 512 ha; environment and green, 570 ha; social service, 90 ha; manufacturing and storage, 51 ha and road 2.6 km. The value of BCR is high in housing developments, 0.78, and followed by total growth and social service, 0.35 indicating the limited effectiveness of the Plan. In contrary, the value of BSR for all variables ranges from 0.2 to 1, which shows proposed land area was large enough to accommodate the new developments within planning period. Most importantly, major factors contributed to limited implementation include spatial variables, absence of monitoring and evaluation, lack of commitment of officials and political leadership influence.

Although this study provides important information with regard to implementation of land-use plan of the City, the results should be considered only as an initial step towards understanding the links between land-use plan and its implementation. Hence, further researches are needed on several fronts. First, this study outlined only one approach, which by itself not sufficient, and plan implementation should be evaluated with the use of multiple approaches of analysis. Moreover, the study has examined a plan of single planning period. It is recommended that, implementation of plans in more planning periods should be analyzed, as comparative analyses would provide an increased understanding of effectiveness of spatial planning. Most importantly, compatibility of nonconforming developments with existing land-uses and spatial distribution of services should be examined which can be used in the consequent planning in order to ensure balanced development and sustainable urban environment.

Acknowledgements This research is granted by Adama Science and Technology University. The findings and opinions reported are those of the authors and are not necessarily endorsed by the funding organization.

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