



DEVELOPMENT OF A NEW INDICATOR WITH ITS APPLICATION TO NATIONAL AND STATE LEVEL DATA

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ABSTRACT An attempt has been made to develop a formula for a new indicator namely healthy literate-working life expectancy (HLWLE) by combining all the three factors—health, literacy and working in a single index. A number of particular cases and various inequalities can also be derived from this proposed index. However, the proposed index is applied to Indian data along with some selected states. The analysis was performed generally to bring out the clear picture of the social development scenario in the context of Indian people.

KEYWORDS :

INTRODUCTION:

India, a developing country, has been experiencing remarkable increase in life expectancies over a period of more than twenty years. The question arises whether the health condition of the people has also improved with the increasing lifespan. Good health and well-being are one of the important components amongst the seventeen Sustainable Development Goals of United Nations (www.undp.org). The recognition of literacy as a major determinant of health status in developing countries has emerged during 1970s (Grosse and Auffrey, 1989). Illiteracy has a direct impact on health status of a person as he/she will not be able to read the instructions on a medicine bottle and also are less likely to know facts about AIDS, malaria and other infectious diseases (United Nations, 2008).

Some studies have shown that low-literacy individuals have less knowledge of their health conditions and treatment regimens, have lower self-management skills, have higher rates of chronic illness and do not effectively participate in preventive care (McCray, 2005). Moreover, people with inadequate literacy are less likely to know basic elements of their care plan for diabetes and hypertension (e.g., low salt diet, normal range for blood pressure or blood glucose etc.) and will also misread directions on prescription labels (Baker et. al, 1998). In addition to this, illiterate people, particularly mothers, are also more likely to adopt poor nutrition and hygiene practices in their homes which might lead to higher rates of diseases and other health-related issues. This, in turn, raises demand for medical services and also causes job absenteeism due to illness on the part of either the parent or the children (UNESCO, 2010). Thus to get proper medical facilities and for acquiring a healthy life, people should be well paid for their work. But due to lack of literacy, an income of an individual gets reduced and also is excluded from better-paying positions or jobs which in turn also affect the health of a person.

People with low literacy also suffer from a high occupational accident rate since they do not understand the instructions for operating the machines which, in turn, put their own health along with the co-workers at risk (Martinez and Fernandez, 2010). Furthermore, children of low wages people are forced to enter the labor market like construction, manufacturing, and mining factories etc., at an adolescent age for the survival of their families which, in turn, will affect their health as children will have the higher risk of injuries in their work. So, it can be said that besides certain health behaviors viz., drinking, smoking, poor nutritional status etc., a person's income, educational level and occupation also play a unique role in a person's overall health (National health committee, 1998).

These socio-economic determinants interact to influence health and an improvement in any of these will upgrade both health behaviors and outcomes among individuals. Higher income is likely to improve the health status of a person and being in good health also increases a person's earnings potential. Again higher literacy is associated with higher earnings at an increasing rate while low literacy is negatively related to lower employment rates which lead to poverty among the people. The more educated population may be in better health due to higher levels of health literacy, health knowledge, or improved interactions with the healthcare system (Mirowsky and Ross 2003; Cutler and Lleras-Muney 2010). Poor people leads to shorter life as the individual is unable to meet the basic needs of food, health and shelter

and eradication of poverty will signify more education and as a result, the overall quality of life will be improved. Thus health, literacy, and employment are associated with each other as productivity in the labor force increases with the improvement in the condition of health and the level of person's productivity is enhanced by his level of education.

Several studies in the early decades have shown that literacy, employment and health condition of a person in a society are technically measured by literate life expectancy, working life expectancy and disability-free or healthy life expectancy respectively. Lutz (1995) defined Literate Life Expectancy (LLE) as expected number of years a person lives in a literate state under current mortality and literacy conditions. Further, working life expectancy (WLE), as defined by Saw Swee Hock (1957), is the number of years a person is expected to live on an average in the working state under the current mortality and working situation. On the other hand, Sander (1964) proposed health expectancy (HE) as a health indicator which is defined as the number of years a person could expect to live in good health if the current mortality and morbidity rates persist.

Likewise, by combining all the three mentioned conditions, viz., health, literacy, and employment together, one may be interested in having an idea about the average number of years lived by a person with healthy, literate and working status when the current mortality, healthy, literacy and working status prevail. This indicator can be proposed as Healthy Literate Working Life expectancy (HLWLE). It may be interpreted as the expected number of years a person lives in a literate, working and healthy state i.e., the average number of years lived by a person who is able to read and write, employed and also free of diseases under the current mortality, literacy and morbidity conditions. It reflects in one number: life expectancy, literacy, employment, and health.

The proposed indicator is largely a demographically-based index and it is a numerical sum of social development which does not need any assumption or adjustment. Various inequalities and particular cases can also be derived from the proposed index. The essentiality of HLWLE lies in the fact that it will help to examine whether additional years of the life of a person are spent in good health with better educational and employment status. The concern over social welfare has increased as the world moves into the 21st century and the developed nations are distressed about the burden of providing health care, education, the creation of jobs, and the urban size and growth of their cities (Medina, 1996).

In the backdrop of the above discussion, the present paper attempts to present a new social indicator which will help to monitor the performance of a nation and will also assist the policy makers in formulating national goals and priorities. It is believed that by implementing the HLWLE indicator in any region or country by sex differentials will bring out the comprehensible picture of the social development conditions of each population group.

OBJECTIVES:

The following are the objectives of the present study:

1. To develop a formula for Healthy Literate Working Life Expectancy (HLWLE) index.
2. To derive different inequalities and a number of particular cases

from the proposed index.

- To apply this index and the particular cases in India along with some selected states representing different zones of India namely, Assam from North-East zone, Gujarat from West zone, Kerala from South zone, Rajasthan from North zone, Uttar Pradesh from Central zone and West Bengal from East zone based on 2011 census data for both the sexes.

Formulation Of The Proposed Indicator— Healthy Literate Working Life Expectancy (hlwe):

If the function describing the number of survivors at age x is l_x and L_x denotes the total number of years lived by a cohort in the age group $[x, x+n)$ then life expectancy at age x is given by

$$e_x^0 = \frac{1}{l_x} \sum_x L_x \tag{1}$$

where ω represents the highest age category i.e., 60+.

Let ${}^n P_{lx}$, ${}^n P_{wx}$ and ${}^n P_{hx}$ be the proportions of literate, working and healthy persons at age groups $[x, x+n)$ respectively then the literate life expectancy, working life expectancy and healthy life expectancy at age x are given by the following equations :

$$le_x^0 = \frac{1}{l_x} \sum_x [{}^n P_{lx} * {}^n L_x] \tag{2}$$

$$we_x^0 = \frac{1}{l_x} \sum_x [{}^n P_{wx} * {}^n L_x] \tag{3}$$

$$he_x^0 = \frac{1}{l_x} \sum_x [{}^n P_{hx} * {}^n L_x] \tag{4}$$

Similarly, one can derive HLWLE, denoted by $hlwe^0$, which represents the expected remaining healthy as well as literate and working life simultaneously of an individual of age x

$$hlwe_x^0 = \frac{1}{l_x} \sum_x [{}^n P_{hlwx} * {}^n L_x] \tag{5}$$

as where ${}^n P_{hlwx}$ is the age-specific proportions of healthy, literate as well as working persons simultaneously at age group $[x, x+n)$.

Inequalities:

One can derive various inequalities as shown below:

$$hlwe_x^0 \leq hle_x^0 \leq he_x^0 \leq e_x^0 \tag{6}$$

$$\text{or, } hlwe_x^0 \leq hle_x^0 \leq le_x^0 \leq e_x^0 \tag{7}$$

$$\text{or, } hlwe_x^0 \leq lwe_x^0 \leq le_x^0 \leq e_x^0 \tag{8}$$

$$\text{or, } hlwe_x^0 \leq lwe_x^0 \leq we_x^0 \leq e_x^0 \tag{9}$$

$$\text{or, } hlwe_x^0 \leq hwe_x^0 \leq he_x^0 \leq e_x^0 \tag{10}$$

$$\text{or, } hlwe_x^0 \leq hwe_x^0 \leq we_x^0 \leq e_x^0 \tag{11}$$

where lwe_x^0 , hwe_x^0 , and hle_x^0 represents literate-working life expectancy, healthy-working life expectancy and healthy-literate life expectancy of an individual of age x respectively.

Mathematically, the above inequalities can be proved as given below:

(1) Since ${}^n P_{lx} \leq 1$, ${}^n P_{wx} \leq 1$, ${}^n P_{hx} \leq 1$ and as proportions are decreasing function of number of factors, so we have

$${}^n P_{hlwx} \leq {}^n P_{lx} \text{ (or } {}^n P_{lx} \text{ or } {}^n P_{wx}), {}^n P_{hlwx} \leq {}^n P_{wx} \text{ (or } {}^n P_{wx} \text{ or } {}^n P_{lx}), {}^n P_{hlwx} \leq {}^n P_{hx} \text{ (or } {}^n P_{hx} \text{ or } {}^n P_{lx})$$

$$\Rightarrow {}^n L_x * {}^n P_{hlwx} \leq {}^n L_x * {}^n P_{lx}$$

$$\Rightarrow \sum_x [{}^n L_x * {}^n P_{hlwx}] \leq \sum_x [{}^n L_x * {}^n P_{lx}]$$

$$\Rightarrow \frac{1}{l_x} \sum_x [{}^n L_x * {}^n P_{hlwx}] \leq \frac{1}{l_x} \sum_x [{}^n L_x * {}^n P_{lx}]$$

$$\Rightarrow hlwe_x^0 \leq hle_x^0$$

Similarly, we can prove the other inequalities as stated above.

As the quantity of factors implicated in the life expectancy reduces, there is an increase in the corresponding value of the index.

Particular Cases:

From the equation, as stated above in (5), numerous particular cases can be pursued. If the proportion of working persons is not considered in equation (5) then we get healthy-literate life expectancy (HLLLE) at various ages under current healthy, literacy and mortality state. Again by ignoring the literate proportions in equation (5) gives healthy-working life expectancy (HWLE) at various ages under current healthy, working and mortality scenario. In addition to this, ignoring the proportions of healthy persons we obtain literate-working life expectancy (LWLE) at different ages under current literacy, working and mortality state.

Similarly, ignoring the proportions of both literacy and working persons in the proposed index i.e., in equation (5), we get healthy life expectancy given by the equation (4) at various ages under current mortality and healthy scenario. In the same way, if the proportions of both healthy and literacy persons are ignored in equation (5), we can obtain working life expectancy at various ages under current mortality and working scenario as given in equation (3). Likewise, equation (5) reduces to equation (2) giving literate life expectancy at different ages under current mortality and literacy scenario when the proportions of both healthy and working persons are ignored. Furthermore, if all the factors health, literacy and working status are not considered in equation (5), then we get life expectancy at various ages given by the equation (1). Thus, we can say that the proposed index is a more generalized one.

Data And Method:

As stated in the objective we tried to estimate HLWLE for India, its selected states and as well as the districts of those selected states for both males and females for the census year 2011. One needs to combine the period life table with the age-specific proportions of healthy, literate as well as working persons together for the estimation of HLWLE. As 2011 is the centered period, the Sample Registration System (SRS) based abridged life tables for the period 2009-2013 is taken for the life tables of India and its selected states. Now for the factor health, we do not have morbidity data, but Census data on disability by their types, age groups and sex for all areas of India at state, district, and city level are available. Different types of disability are 'in seeing', 'in hearing', 'in speech', 'in movement', 'mental retardedness', 'mental illness', 'multiple disabilities' and 'any others'. So for the present study, data on disability were taken from the table C-20 of the 2011 Census of India. A detailed description of each of the disabilities mentioned above can be found on the website of the Office of the Registrar General and Census Commissioner, India (www.censusindia.gov). But the data were organized in mostly 10 year age groups after the age group 9. So we need to transform them to 5 year age group by using Karup King formula in order to make it same with the abridged life table. Then the proportion of disability-free persons is calculated for each census year under consideration.

Further census of India also provides data on literate and working population by age and sex. Data on working population are divided into a number of categories labeled as 'main workers', 'marginal workers', 'nonworkers', 'seeking/available for work'. For the present study leaving the categories 'seeking/available for work' and 'nonworkers', we combine the remaining categories for the calculation of working population. Information about the total population is also provided in the census of India. Thus, one can calculate the healthy proportions, literate proportions and working proportions by age and sex wise. Hence, literate life expectancy (le_x^0), working life expectancy (we_x^0) and healthy life expectancy (he_x^0) can be obtained.

But the difficulty arises in estimating the proposed indicator HLWLE as Census of India do not provide information on healthy, literate and as well as working persons simultaneously. Therefore, our first purpose is to find the value of for estimation of. The present study has attempted to find the indicator as mentioned in the following steps below:

Step 1: For a particular age interval say $[x, x+n)$, generate a random sample from $(1, i)$ of size j where i represents the total population and j denotes the literate population.

Step 2: Obtain another random sample between $(1, i)$ of size k where k represents the working population for the given age interval.

Step 3: Obtain the next another random sample from $(1, i)$ of size l where l indicates the healthy population for the given age group say $[x, x+n)$.

Step 4: Find the common numbers between the three samples obtained in Step 1, Step 2 and Step 3 using random number mechanism from the underlying data.

Step 5: Count the common numbers obtained in Step 4. Subsequently, the outcome procured is taken as the healthy literate as well as working persons simultaneously for that particular age interval say $[x, x+n)$.

Step 6: Find the proportion of healthy literate as well as working persons simultaneously for the given age interval.

Step 7: The above sequence of steps is repeated 100 times. As a result, for the particular age interval the proportion has been found quite a few(100) times.

Step 8: Take the mean of all the 100 proportions obtained in the preceding steps. The obtained final result has been taken as the value of for that particular age interval say $[x, x+n)$.

In a similar way, the whole mechanism is repeated for the other age bands starting from age 0 to older age 70+. The calculations obtained are carried out with the help of R programming software package. The description of the program is given in the Appendix A5.1 One interesting feature noticed in all the age groups is that if we take the product of all the literate ,working as well as healthy proportions simultaneously i.e, by assuming all the three factors as independent, the value obtained is very near to the value obtained by the technique as mentioned above.

RESULTS AND DISCUSSION:

The obtained results of healthy literate-working life expectancy at birth based on 2011 census for both the sexes separately at the national and state level are presented in Table 1 and Table 2 along with the other social indicators, namely, healthy-literate life expectancy($hlwe^o$), literate-working life expectancy(lwe^o), healthy-working life expectancy(hwe^o), healthy life expectancy(he^o), literate life expectancy(le^o), working life expectancy(we^o) and life expectancy at birth (e^o) respectively. Due to a limitation of the space, the estimates are presented only at birth

Table 1: Values of various socially developed indicators along with Life expectancy at birth in India and Some of its Selected States, Males, 2011.

India and States	Values of HLWLE at birth and various other life expectancy at birth along with life expectancy at birth(Males)							
	$(hlwe^o)$	(hle^o)	(lwe^o)	(hwe^o)	(he^o)	(le^o)	(we^o)	(e^o)
India	22.73	43.89	23.35	29.54	63.79	45.15	30.41	65.80
Assam	20.96	40.47	21.40	28.15	60.50	41.37	28.80	61.90
Gujarat	24.55	47.39	25.06	29.56	64.41	48.46	30.22	66.00
Kerala	26.60	59.62	27.43	27.59	69.37	61.66	28.47	71.80
Rajasthan	21.71	40.15	22.42	29.53	62.29	41.71	30.77	65.40
Uttar Pradesh	20.78	38.57	21.29	29.52	60.88	39.51	30.31	62.50
West Bengal	23.09	47.42	23.69	29.19	66.44	48.76	29.97	68.50

Table 2: Values of various socially developed indicators along with Life expectancy at birth in India and Some of its Selected States, Females, 2011.

India and States	Values of HLWLE at birth and various other life expectancy at birth along with life expectancy at birth(Females)							
	$(hlwe^o)$	(hle^o)	(lwe^o)	(hwe^o)	(he^o)	(le^o)	(we^o)	(e^o)
India	7.98	33.79	8.14	13.93	67.26	34.58	14.27	69.30
Assam	6.81	32.60	6.92	11.47	63.37	33.26	11.72	65.10
Gujarat	7.86	38.14	7.99	12.08	68.80	38.91	12.31	70.50
Kerala	8.09	60.54	8.29	8.66	75.10	62.58	8.89	77.80

Rajasthan	8.00	23.76	8.18	19.38	65.68	24.29	20.18	70.00
Uttar Pradesh	4.15	24.69	4.22	9.60	60.30	25.11	9.79	65.20
West Bengal	6.07	39.46	6.19	9.10	69.65	40.38	9.29	71.60

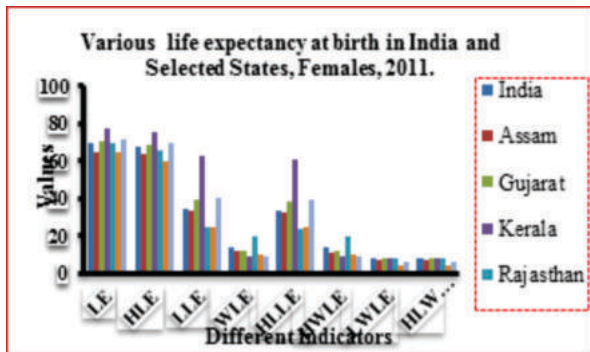
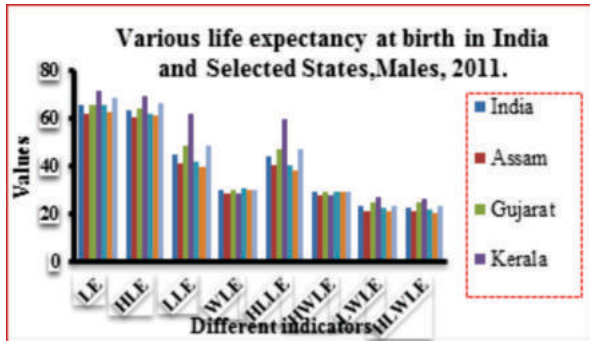


Figure 1: Sex-wise various life expectancy at birth in India and some of its selected states for the period 2011.

Table 1 depicts that based on 2011 census, the healthy literate working life expectancy at birth for males in India is 22.73 years. When comparing the ratio of HLWLE at birth to LE (life expectancy) at birth, it is found that for males, 34.54 percent of their remaining life out of the total life expectancy 65.80 years in 2011 was spent in having these factors simultaneously. On the other hand, Table 6.2 reveals that the corresponding percentage for Indian women is only 11.54 out of the total life expectancy of 69.30 years. This speaks about the plight of quality of life lived by Indians specially the women. The tables (Table 1 and Table 2) indicates that for males, the highest HLWLE at birth prevailed in Kerala with 26.60 years and the lowest is found in Uttar Pradesh with 20.78 years while for female counterparts also similar states performed the highest and lowest position with 8.09 years and 4.15 years respectively. It is also noted that female healthy literate working life expectancy values are much lower as compared to their male counterparts. Comparing the national and selected state-wise values of HLWLE at birth it is observed that among the males only the states Gujarat, Kerala and West Bengal are above the national level while the other states namely Assam, Rajasthan and Uttar Pradesh are below the national level. But in a case of females, only Kerala and Rajasthan had scored above the national value of HLWLE at birth. Although Kerala is the most socially developed state of India, the performance of the state is not satisfactory among the females if we consider health, literacy and working status simultaneously. One striking feature is that though life expectancy data is found to be higher for females but in respect of education, employment and health status females are much lagging behind the males (Refer Tables 1 and 2). It is also observed that when additional number of demographic factors are incorporated with the life expectancy the value of the index has been decreasing (Refer Figure 1).

To examine the factor that has mainly influenced the value of HLWLE the values of other indicators namely literate-working life expectancy, healthy-working life expectancy, healthy life expectancy, literate life expectancy, working life expectancy are also calculated which are presented in Table 1(for males) and Table 2(for females). The obtained values of literate life expectancy(LLE), working life expectancy (WLE) and healthy life expectancy (HLE) are validated with the

values obtained by the methodology developed by Lutz (for LLE), Saw-Swee Hock (for WLE) and Sanders (for HLE). Also, the life expectancy at birth values is checked with the values published in SRS report 2009-13. Comparing all the social development indicators, namely, healthy-literate life expectancy (HLLE), literate-working life expectancy (LWLE) and healthy-working life expectancy (HWLE) at birth in India and the selected states it is noticed that healthy-literate life expectancy is the highest in all the selected states including India among the males. A similar situation has also been observed among the females (Table 2). As the values of working life are low for both the sexes in all the selected states including India, hence the values of HWLE and LWLE at birth are lower. It is noteworthy to mention that the values of working life are much lower for both the sexes among all the indicators. It is also evident from the above tables that except the state Kerala, the values of LLE at birth are not satisfactory for both the sexes. The poorest LLE at birth is exhibited by the states Uttar Pradesh and Rajasthan for males and females with 39.51 years and 24.29 years respectively. This means that the women of Rajasthan are spending nearly two third of years of life without having the basic opportunity i.e. literacy. Even at the national level, the values of LLE at birth for females is not at all satisfactory since they have spent less than half of the years in education.

Comparing the health scenario it is observed that Assam (for males) and Gujarat (for females) is in a better position as compared to other selected states. The worst situation is observed in Rajasthan among the males while for females Uttar Pradesh is not satisfactory. This is supported by the fact that the gap between LE and HLE at birth in Assam is 1.4 years while for Gujarat it is 1.7 years. In Rajasthan, the difference is 3.11 years. Also, the health scenario of the women of Rajasthan is not satisfactory as the gap between LE and HLE at birth is 4.32 years. Another important finding is that although the number of survival years is higher for women as compared to men, males are enjoying more healthy life as compared to female counterparts. For example, the gap between female LE and HLE at birth in the state Uttar Pradesh is approximately 5 years while for males is 1.62 years. But in West Bengal, females are enjoying more healthier life as compared to males.

Moreover, a significant disparity is also observed between the LE and WLE at birth in all the selected states including India for both the sexes. The gap between LE and WLE at birth is more prominent in Kerala. Comparing the state-wise working scenario it is seen that the lowest WLE at birth prevailed in Kerala for males with 28.47 years while in the case of females, also the same state prevailed the lowest position with 8.89 years amongst all the selected states under consideration. The highest WLE at birth prevailed in Rajasthan for both the sexes with 30.77 years (for males) and 20.18 years (for females) respectively among the selected states. The tables also reflect the existence of huge gender variation in all the essential factors of life-literacy, employment, and health. The broad gender variation is found in the employment sector in all the selected states including India. This phenomenon could be explained by the fact that underreporting of work participation as most of the Indian women do unpaid household work (Dhillon and Ladusingh, 2011). Due to this possibly, there is also a wide gap in the values of HLWLE at birth for females in comparison to males. In addition to this, Chattopadhyay and Sinha (2010) pointed out that both the level of education and the number of survival years are poor in the states, namely, Assam, Rajasthan and Uttar Pradesh. This attributes may be the cause for lowering the figures of HLWLE at birth in these states for both the sexes. Thus, mainly the two factors literacy and working status has influenced heavily by the values of all the indicators namely, HLWLE, HLLE, LWLE and HWLE at birth. In spite of the consistent increase in the level of education in India over the decades, the pace of increase is slow in some states of India, especially amongst the females. Another important striking feature is that although in Kerala female LLE at birth had surpassed the male LLE, the value of HLWLE for females in comparison to males is lower to a great extent. This has happened probably due to low work participation rate among the females in Kerala. Improvement in the educational levels of women in the state have created in them strong preference for white collar and salaried jobs and thus reducing their willingness to take up manual work (Devi K.R,2002). Though Kerala ranks high on the indicators of demographic progress in terms of economy it has not experienced similar levels in terms of work participation particularly among the females (Mazumdar and Guruswamy,2006).

CONCLUSION:

The study tried to develop a new indicator mainly to examine the

leading sectors of social indicators namely health, literacy and working by incorporating all the three factors in one formula. The analysis was performed generally to bring out the clear picture of the social development scenario in the context of Indian people. The selection of the states on the basis of their geographical location will bring out the regional disparity prevailing in India. Due to the scarcity of data, the value of the proposed index has been obtained technically as mentioned above. Based on the findings of this study, the state wise figures display that Rajasthan should be highly focussed in respect of education and health especially among the females. The study also explored that the main contribution to the HLWLE gap between the two sexes is basically due to employment and literacy. Additionally, the issue of educated unemployed in Kerala, in particular, the females should be considered as an important dimension by the policymakers. The attention towards the sex differential should also be highly prioritized by the future researchers and government policymakers. A coherent policy must be formulated urgently for increasing the level of education amongst the women mostly in the less developed states namely Rajasthan and Uttar Pradesh so that the gender gap gets minimized.

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