Accessibility of Norwegian Municipalities Websites: A Qualitative System Dynamics Approach

Ahmed A. Abdelgawad[1], **Mikael H. Snaprud**[1], and **John Krogstie**[2]

[1] University of Agder
Department of Information and Communication Technology
Jon Lilletunsvei 9, NO-4879 Grimstad, Norway
ahmedg@uia.no, mikael.snaprud@uia.no

[2] Norwegian University of Science and Technology
Department of Computer and Information Science
Sem Sælandsvei 7-9, NO-7491 Trondheim, Norway
krogstie@idi.ntnu.no

Abstract. *Access to all public websites is crucial to assuring equal opportunities for all citizens to participate in society. Several studies have been carried out to analyse the accessibility of websites. However, we have not been able to find any studies on the factors (other than technical) affecting website accessibility. The purpose of this paper is therefore to explore different factors prior to the web page development that may have an influence on the accessibility of municipal websites in Norway. This is achieved through reviewing relevant literature and performing a set of in-depth interviews with web-masters and web-editors from various Norwegian municipalities. The findings from these sources were compiled into a Causal Loop Diagram.*
Several leverage points to enhance public websites accessibility were discovered by exploring the Causal Loop Diagram:

- *Increasing the budget devoted to the workforce, paying more attention to the selection process while recruiting and retaining the experienced workforce members.*
- *Keeping the desired development rate at a level lower than the capacity of the available workforce.*
- *Training the workforce in HTML and WCAG, in addition to updating technology, are possible long-term investments.*

Key words:
Accessibility, Web-accessibility, eGovernment, Public Websites, and Qualitative System Dynamics.

Introduction

Accessibility of a website refers to the ability of all people to use this website irrespective of their disabilities or the terminals they use to access internet (W3C 2008). Websites should be designed in a way that complies with certain set of rules and guidelines to be accessible. It is an important aspect of websites in general, and of public websites in particular, to be able to serve all citizens equally. For example if a webpage is de-

signed to receive the user's input merely through mouse clicks, then people with disabilities preventing them from using a mouse or people using e.g. mobile phones to browse the internet will not be able to use this webpage.
Web-accessibility can be assessed in terms of compliance with a set of accessibility metrics defined by specific guidelines like Web Content Accessibility Guidelines WCAG 1.0, WCAG 2.0 (W3C 2008), and ISO 9241-20 (ISO 2008). Furthermore, it may be evaluated quantitatively using methodologies like Unified Web Evaluation Methodology[1] UWEM (Nietzio, Strobbe, and Velleman 2008).
Many research projects have addressed evaluation of public websites accessibility, for instance (Observatorio de Infoaccesibilidad Discapnet 2006; EIAO 2008; eGovMon 2008). In addition governments carry out benchmarking and pass laws to increase public websites accessibility. In Norway, the Agency for Public Management and eGovernment DIFI is responsible for an annual evaluation of governmental websites (DIFI 2009a). Web-accessibility is one of three indicators measured by DIFI to encourage governmental agencies to increase the accessibility of their websites.
In 2008, the United Nation's eGovernment Development Index for Norway was 0.8921, ranking the country third in the entire world (UNDESA 2008). However, from an accessibility point of view, the Norwegian public websites achieved an average score of 54% in the same year according to DIFI (DIFI 2009a), leading to two pressing questions: why is this so and how to fix the situation. System analysis is a promising tool used in the search for answers.
Although a public website as an Information System consists of people or human resources component (website editors, web-masters, vendors' developers … etc.), besides the IT technical components (data, hardware, software and telecommunications … etc.) (Oz 2008), we have not been able to find studies focusing on other factors than technical ones affecting website accessibility.
Motivated by this, the paper seeks to explore the different factors and cause-effect relationships governing the processes having an impact on the accessibility of Norwegian municipal websites. The results are based on a set of in-depth interviews with web-masters and web-editors from different Norwegian municipalities in addition to related literature. The identified relationships have subsequently been compiled into a Causal Loop Diagram.
The remainder of this paper is organised as follows: The first section gives a brief introduction to the applied methodology and an outline of the sources of information used. The subsequent section explores the system's Causal Loop Diagrams. Finally, the paper discusses the findings.

Methodology

To convey the main results of this paper and make it easy to explore the causalities, loops, and feedback effects in the system, a qualitative System Dynamics graphical tool called the *Casual Loop Diagram* or *Influence Diagram* was chosen.
Follows a brief on the idea and notation of Causal Loop Diagram and the information sources employed to construct them.

1 Number of failed web accessibility tests divided by number of all tests applied per webpage or per website when evaluating a webpage or a website respectively.

Causal Loop Diagram

Causal Loop Diagram is a tool used to visualise variables relationships and feedback effects of systems. An example of a Causal Loop Diagram is shown in figure 1. The Causal Loop Diagram consists of variable names and arrows among them.

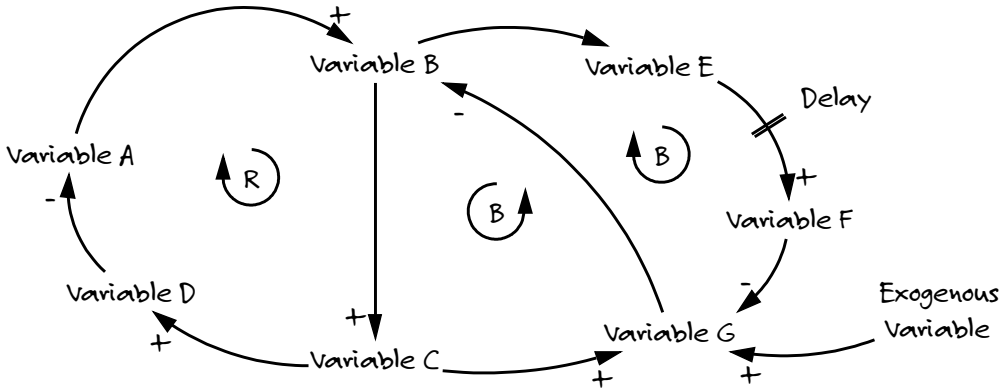


Figure 1: Casual Loop Diagram example

The arrows between every two variables differ in sign (positive or negative) to express direct or inverse cause-effect relationships between the two variables they connect. Sometimes the arrows are interrupted by two parallel lines to indicate time delay. The arrows can compose circular causality and develop into two different sorts of loops, either ones with exponentially growing/decaying behaviour called *reinforcing loops* (denoted by R), or loops with goal-seeking behaviour called *balancing loops* (denoted by B). The interactions among different loops decide the final behaviour of the system (Wolstenholme and R. G. Coyle 1983; Geoff Coyle 2000; Sterman 2000).

Information Sources

The source of information to build the Causal Loop Diagram in this paper is a set of in-depth interviews with 7 responsible editors and web-masters from different Norwegian municipalities, namely: Hole, Holmestrand, Grimstad, and Trondheim municipalities.[2] These in-depth interviews were accompanied by an extensive literature review on management applications from areas possessing similarities to public website development and management, such as software development, web maintenance and online community networks (Abdel-Hamid and Madnick 1991; Madachy 2008; Sterman 2000; Lyneis and Ford 2007; Kong, Liu, and Lowe 2005; Otto and Simon 2008).

Causal Loop Diagram of Website Accessibility

This section explores the system's Causal Loop Diagrams: the website development process focusing on web-accessibility, workforce focusing on productivity and work quality in terms of the accessibility of developed webpages, workforce training, use of con-

2 Trondheim municipality is an example of a large municipality (one of the 10 largest in Norway), where the number of website editors exceeds 500 (full-time and part-time), while Hole, Holmestrand and Grimstad are examples of smaller municipalities employing less than 20 active editors (full-time and part-time). The factor that distinguishes Grimstad in this study is that it is in the process of replacing its website with a newer version.

sultants from vendors, the process of updating technology used in building the municipal website, and an overall picture of the system.

Workforce and website accessibility

Web editors are the people responsible for editing the webpages and publishing them on the municipal website. Editors have varying experience and knowledge, accordingly their productivity and the accessibility of their edited webpages vary. Consequently overall website accessibility vary.

Enhancing accessibility of the municipal website is desirable, especially when results in achieving a good ranking on DIFI's annual evaluation. Nevertheless, according to interviewees, website accessibility is not in the municipality's list of priorities, generally implying a limited part of the budget devoted to accessibility. Therefore, probably a short-term accessibility enhancement will lead to a budget cut, or in the best case, stagnation, i.e. a budget devoted to accessibility has an inverse cause-effect relationship with accessibility.

Figure 2 compiles the cause-effect relationships connecting workforce and website accessibility. To easily explore these cause-effect relationships, we will assume a decrease in the website accessibility. Consequently, the budget devoted to accessibility increases – usually slightly (if any); hence the budget devoted to the workforce increases. Having a larger budget devoted to the workforce would mean an increased hiring rate, decreased turnover or both. All cases lead to an increase in the workforce, thus raising the webpages development rate, which subsequently increases the website size in terms of the number of webpages, increase the quality assurance in terms of re-editing the old inaccessible webpages or both.

More webpages (with some level of inaccessibility) mean less overall website accessibility. This creates an undesirable reinforcing loop R1. On the other hand, more quality assurance means more overall website accessibility. This creates a desirable balancing loop B1.[3]

From another perspective, an increase in the workforce – assuming mild rationality when recruiting and retaining experienced workforce members – enhances the workforce mix, a factor which has the following effects:

- increasing the potential and thereafter actual developed webpage accessibility, creating a desirable balancing loop B2, and
- increasing the potential and thereafter actual productivity, creating another path and strengthening the path from workforce to webpages development rate, and creating another undesirable reinforcing loop R2.

While developing webpages, editors learn. As the webpages development rate increases, learning by doing increases. This produces two effects after a delay:

- increasing website accessibility through increasing the actual developed webpage accessibility, creating 2 desirable balancing loops B4 and B5[4] (both strengthen B2), and
- increasing actual productivity, hence webpages development rate, creating a desirable reinforcing loop R3.

3 Both hiring and turnover rates transfer the effect from a budget devoted to the workforce in the same direction, thus for the purpose of simplicity, we will consider them as one path.

4 The path from workforce to webpages development rate is strengthened by another parallel path through workforce mix, potential and actual productivity. This parallel path causes B4 to be strengthened by another desirable balancing loop B5.

Nevertheless, after a continuance of high webpages development rate, the desirable effects of loops B4, B5 and R3 are weakened by fatigue, leading to two effects:

- decreasing website accessibility by decreasing the actual developed webpage accessibility, creating 2 undesirable reinforcing loops R4 and R5[5] (which weaken B4 and B5), and
- decreasing the actual productivity, hence the webpages development rate, creating an undesirable balancing loop B3 (which weakens R3).

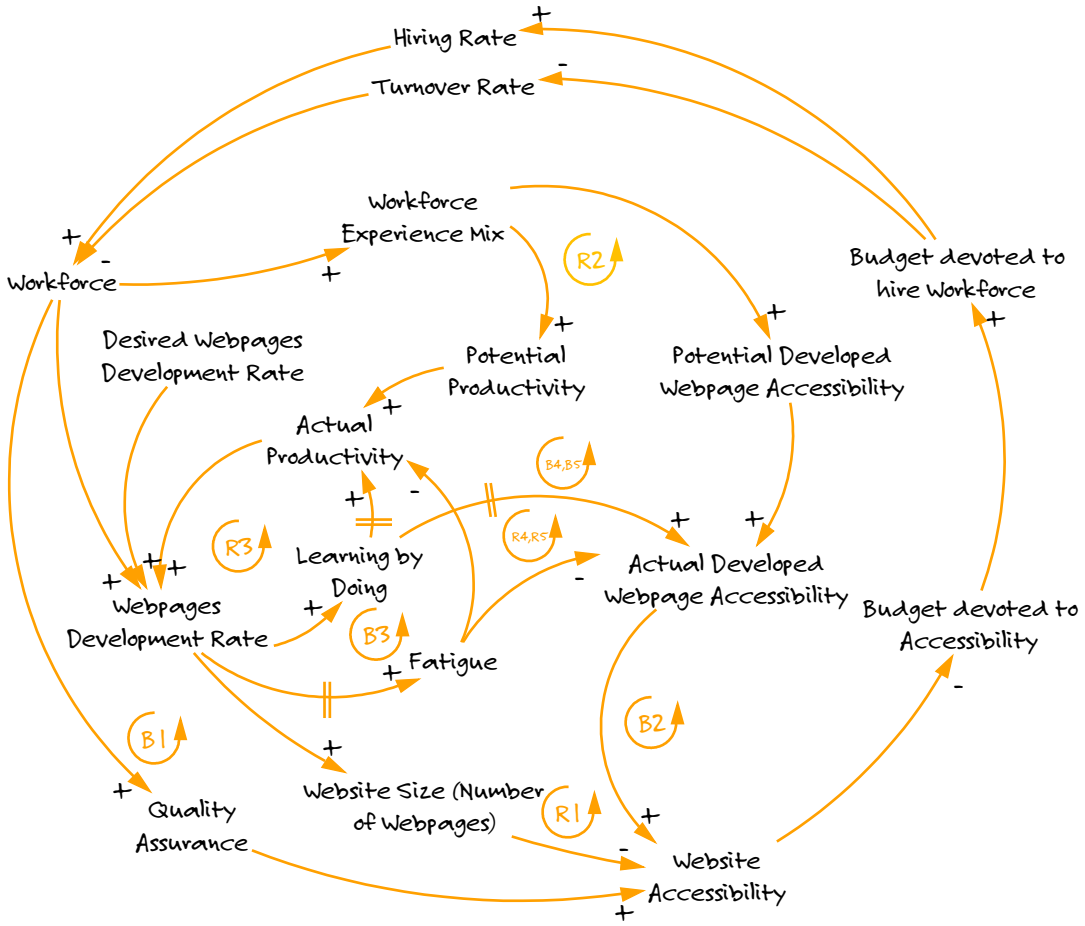


Figure 2: Workforce management

Given the current workforce management policy, the number of reinforcing loops (with undesirable effect on accessibility) equals the number of balancing loops (with desirable effect on accessibility). Keeping the accessibility on the same level is a delicate process. Nevertheless, many leverage points could be utilized to increase accessibility:

- changing the current budget policy increases the budget devoted to workforce to increase the workforce, hence increasing the production capacity,
- giving more attention to the selection process while recruiting, and retaining the experienced workforce members, to increase the experience mix, and
- keeping the desired development rate lower than the capacity of the available workforce.

5 The path from workforce to webpages development rate is strengthened by another parallel path through workforce mix, potential and actual productivity. This parallel path causes R4 to be strengthened by another undesirable reinforcing loop R5.

The above points would increase the desirable effect through assuring the following:

- devote more development time for quality assurance, accordingly increasing the overall accessibility (empowering loop B1 on the account of R1),
- affect accessibility positively through loop B2 instead of productivity through loop R2, using the same number of workforce individuals because of their better workforce experience mix, and
- increasing the desirable effect of loop B4, B5 and R3, without triggering loops R4, R5 and B3.

Unfortunately, as mentioned earlier, accessibility is not on the priority list, moreover the desired webpage development rate is not usually elastic, strengthening all undesirable loops.

Workforce training

Figure 3 explores the expected training effects on the accessibility of a municipal website. As budget devoted to training increases, training activity increases; consequently, the actual productivity and the webpage development rate of the workforce increases, if the desired webpages development rate is increased. The same workforce as a group has the ability to develop webpages at a specific level level of accessibility. At this specific level of developed webpage accessibility, any increase in webpages development will lead to a decrease in the overall website accessibility. Accordingly, devoting more money to accessibility, thus devoting more money to training again through loop R comprising a vicious circle (undesirable reinforcing loop)!

Although increased training seems to have undesirable effect on accessibility through loop R, this is not true. After a time delay (time to digest the new knowledge) training increases the actual developed webpage accessibility, which increases the website accessibility, creating desirable balancing loop B. Furthermore, keeping the desired development rate at a level lower than the capacity of the available workforce will suppress loop R in favour of loop B.

Moreover, devoting a higher budget to training, given that the selection of training programmes in terms of type, duration and quality is rational, would increase the desirable effect. For example, training for workforce members (especially those recently hired) is limited to providing knowledge about how to build webpages using the publishing tools and templates provided by the vendors. Consequently, web editors hardly know about the Hypertext Markup Language (HTML), although HTML is the most widespread internet browsers language. Moreover, HTML is the language of the techniques provided by the World Wide Web Consortium (W3C) to ensure that webpages conform with their stable WCAG1.0 or new WCAG2.0 (W3C 2000b; W3C 2004). According to experts, examples of the positive effect of HTML knowledge on website accessibility exist. Our interviews results are consistent with that. Out of the interviewed municipalities, only the workforce in Hole municipality has good knowledge of HTML and WCAG, which enables them not only to develop webpages but also create templates. This knowledge is reflected in their successful current and historical ranks in the annual public websites assessments by DIFI (DIFI 2009a). Further training opportunities are on how to produce webpages in compliance with WCAG, which is estimated to cost NOK 2,385 per person for 3 hours of training including all expenses. Moreover, online courses are expected to be more cost-saving (DIFI 2009b).

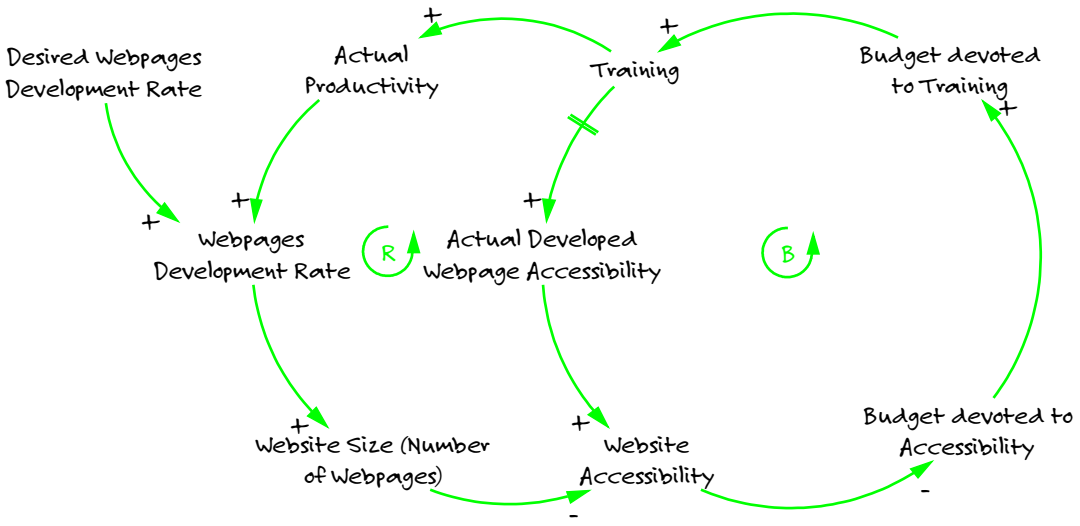


Figure 3: Workforce training

Consultancies with the vendors

DIFI estimates that one hour of IT development support provided to public agencies by internet publishing solutions vendors costs NOK 1,500 (DIFI 2009b). According to Trondheim municipality, the number of support hours could reach from 900 to 1,200 hours per year.

Fortunately, the loop controlling consultancies with vendors is a balancing loop by its very nature. For instance, figure 4 shows loop B, which controls consultancy value. As website accessibility decays, the budget devoted to consultancies with vendors increases, leading to an increase in the resulted number of webpages fixed in terms of accessibility. As the website accessibility increases, the budget devoted to consultancies with vendors is decreased.

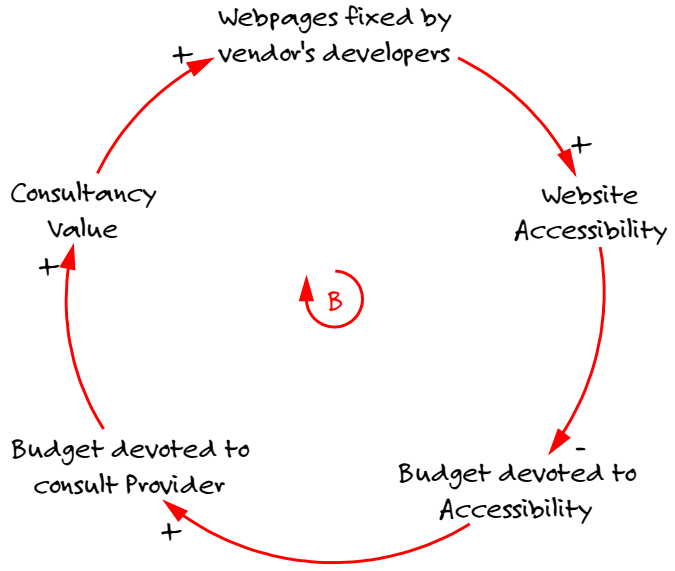


Figure 4: Consultancies with the vendor

Anecdotal evidence indicates that just before the annual public websites assessments by DIFI, some municipalities rush to consult their vendors to fix website problems, aiming at getting a better ranking.
In addition to the high cost, the real problem behind consulting the vendor is that although enhancing the accessibility quickly, the effect is short-term. This is due to the addition of new webpages and templates over time (having the usual accessibility level), at the same time purging the obsolete ones (which might be the ones fixed by the vendor's developers).

Technology update

The term "technology update" means updating the tools used by the public agencies to build and publish their websites. Technology update enables the website to satisfy its users' evolving needs, as well as comply with the up-to-date IT security requirements. Furthermore, experts in the field claim that using the appropriate web technology greatly affects accessibility. Seen from another point of view, "people clearly link the use of the new technology to better career prospects" (Parent-Thirion et al. 2007), implying that keeping technology up-to-date increases the competitiveness of the workplace, and helps municipalities in retaining their experienced employees.
Figure 5 presents the loops managing the process and decision of technology update. As website accessibility decreases, budget devoted to accessibility (hence to technology update) increases. After fully installing the new technology putting it into operation, actual productivity and webpages development rate increase directly. The immediate response to webpages development rate is an increase in the number of webpages, thus decreasing the accessibility through an undesirable reinforcing loop R. Another delayed response to technology update is an increase in actual developed webpage accessibility, which in turn enhances the accessibility creating a desirable balanced loop B.
Rationality in selecting the new technology in terms of accessibility features, security and stability is the key to achieve the desired effects.

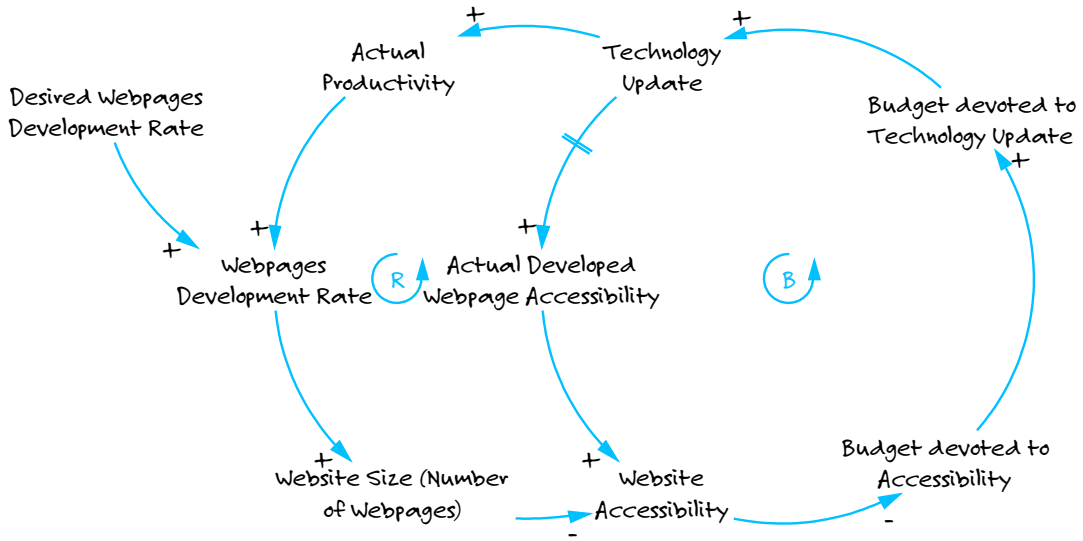


Figure 5: Technology update

DIFI estimates that 1,500 hours are needed to develop one of the current publishing tools (that can not be totally replaced[6]) to comply with the Authoring Tool Accessibility Guidelines ATAG 1.0 (W3C 2000a); multiplying this by one hour of development estimated cost NOK 600 (vendor's internal cost), provides a total of NOK 9,000,000 (DIFI 2009b). The value of this investment although looks high, is low when distributed over time between needed successive updates. For example, the W3C took 9 years between publishing ATAG 1.0 in 2000 and ATAG 2.0 (which is still a working draft) in 2009 (W3C 2009).

Overall picture

Figure 6 presents all formerly discussed loops combined to form an overall picture of accessibility management in a municipal website. The interactions resulted from joining these loop are very interesting.

Loops of workforce management, training, and technology update empower each other through actual productivity and actual developed webpage accessibility. Both variables are long-term investments that the municipality will continue gaining from for a long time after paying for them. As mentioned earlier, opportunities to enhance accessibility through training one or more of the editors in the use of HTML and WCAG cost the municipality very little. Furthermore, updating the used technology is expected to be fruitful in terms of enhancing actual productivity and actual developed webpage accessibility. In addition, it is expected to enhance the working conditions for employees. Finally, keeping the editors workload on a level suitable to their number and capacities will increase the merits of learning by doing, and will suppress the undesirable effect of fatigue on both actual productivity and actual developed webpage accessibility.

Only the loop of consulting the vendor is connected to the rest of the system through the website size (number of webpages) and the budget; as the website size increases, the vendor interacts and fixes some webpages – if requested, accordingly earn some good money.

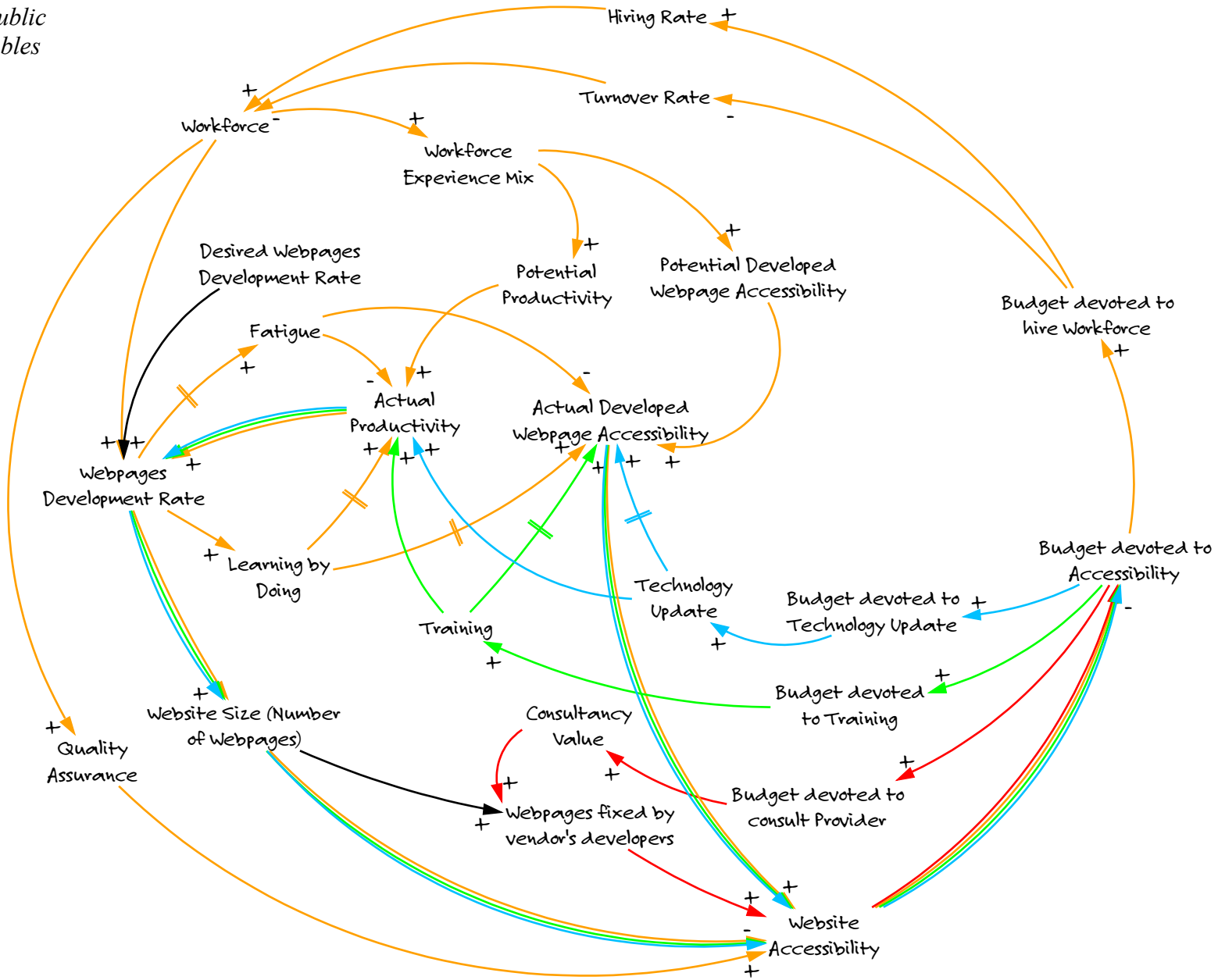
As mentioned earlier, man hour purchased from the vendors is estimated to cost the municipality NOK 1,500. However, the estimated internal cost for the vendor is only NOK 600 per man hour. It is also estimated that an editor in a municipality costs NOK 240 per hour (DIFI 2009b). These numbers could recommend recruiting in-house developers in big municipalities, and even smaller neighbour municipalities could bear that cost if they group together.

Comparing DIFI's estimated cost of technology update and training to the cost of consultancies per year in a municipality (for example, Trondheim) illustrates the substantial opportunity of this.

Under the budget constraints in the municipalities and in compliance with Norwegian anti-discrimination laws, the central government may take very positive steps regarding training editors from the municipalities, updating technology and putting conditions on vendors supplying public agencies with publishing tools in order to make these tools in compliance with, for example, the latest ATAG.

6 Cost drops significantly for replacing a publishing tool, according to DIFI's estimates it will cost only NOK 60,000.

Figure 6: Overall picture of public website accessibility key variables



Concluding discussion

The achievement of public website accessibility offers various opportunities for various groups of people, while lack of public website accessibility deprives them not only from these opportunities but also from the services that they should normally receive.
Many leverage points to enhance public website accessibility were discovered by exploring the system's Causal Loop Diagram:

- increasing the budget devoted to the workforce, giving more attention to the selection process while recruiting and retaining the experienced workforce members in order to improve the experience mix, are important factors in enhancing accessibility,
- keeping the desired development rate at a level lower than the capacity of the available workforce, is another important measure that allows more time for quality assurance, empowers the desirable loops, and enhances accessibility, and
- training the workforce in HTML and WCAG, in addition to performing technology update, are long-term investments than consulting the vendors to solve accessibility problems.

In addition, the Causal Loop Diagram can be utilised to enhance the mental models of its users. Moreover, they can be used to explain very useful policies that are based on non-straight forward cause-effect relationships hidden in the system to decision-makers. Furthermore, this Causal Loop Diagram is a basis for a System Dynamics quantitative simulation model.

Acknowledgement

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7 http://www.egovmon.no

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