Digital Divide, Knowledge and Innovations

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Abstract
Access to Information and Communication Technologies (ICT) enables the production, use and transfer of knowledge in an efficient and low cost manner. Knowledge is the major factor in the knowledge economy and countries that have limited access to ICT are disadvantaged. This phenomenon is known as digital divide and it pertains to a number of countries. This article synthesizes the relevant literature in order to explore relationships of digital divide with knowledge asymmetry, information asymmetry, innovation, and knowledge economy. Digital divide in this context mainly causes disadvantages in regard to growth and development for countries with limited access to ICT. A brief comparative case of the republic of Korea and South Africa is discussed to illustrate the relationship between digital divide and knowledge economy. It is argued that that the movements toward open source and especially open innovations present opportunities for gaining knowledge and skills that may reduce the digital divide.

Keywords: Digital divide, knowledge economy, knowledge management, knowledge asymmetry, information asymmetry, innovation, patents, open source, research and development.

Introduction
The digital divide is one of the well-known phenomena and it resembles a divide between poor and rich. There is a variety of developed solutions since this problem is known by governments and a high share of the population. Nevertheless the solution to accelerate the bridging of the gap has not been found yet. The OECD (2010) performed a study about the results of the PISA test and the use of computer in the OECD countries. The study shows that the children using the computer more often achieved better results in the PISA study. This leads us to the point where it is possible to state the following: Access to Information and Communication Technologies (ICT) is an important means to perform well in formal as well as informal education and to gain knowledge in general (Becta, 2001).

Buckland (1991) distinguishes between three concepts of information. The first is “information-as-process” referring to the communication of knowledge and, therefore the process of informing. The second concept is “information-as-knowledge” that refers to a kind of good transferred
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by communication of knowledge. The third concept is “information-as-thing,” which frames information as an attribute of objects, such as data or documents that are considered to be “informative.” Information used in this paper is mainly referring to “information-as-knowledge.” The concept of knowledge used in this paper refers to the cognitive content that comes in the forms of know-what, know-who, know-why, and know-how (Lundvall & Johnson, 1994).

Besides the problem of getting a job or getting better school grades, the problem of lower access to ICT diminishes innovation opportunities for people, institutions and countries. On the one hand this is caused by the loss of possibilities to gain information and knowledge. On the other hand because of the missing ability to share and spread the knowledge the people have. Given these factors that can affect the research and development (R&D) there are also other factors related to innovation. For example, there is the possibility to work together with people from other countries. On the one hand, this possibility can be restricted by communication limitations, and on the other, by a knowledge asymmetry (Dutta & Bilbao-Osorio, 2012).

Given this fact, digital divide affects all ages of people who have a need for gaining knowledge and are potential researchers. The first objective of this paper is to give an impression of the meanings of knowledge, knowledge economy and knowledge management and the role of innovation in regard to that. The second objective of this article is to examine and question the relation of digital divide to knowledge and innovation. Further problems in regard to innovation that will be addressed by this paper are first the consequences of knowledge and information asymmetries for innovation, second, the relation of digital divide to knowledge management and the knowledge economy. The third and final objective is to elaborate on some possible ways to bridge the digital divide as well as the discussion of open source and open innovation in regard to it.

Figure 1 shows some causes and effects of the digital divide as well as ways to bridge the digital divide discussed in this work. The digital divide affects the knowledge economy as well as knowledge management like a barrier to trade which leads to a knowledge asymmetry. Some countries or regions have an advantage because of better development and better access to ICT. Therefore, they are gaining a higher amount of knowledge and are more able to transmit or use it. This leads to the conclusion that the digital divide affects the possibility and the way how research and development is done and therefore affects the amount of innovations which can be expected. Bridging the digital divide opens up development and growth in less developed countries. The possibility to innovate is one major factor in regard to international competition on various markets. Several solutions are proposed to overcome the digital divide and close the existing gap. One of those solutions is open source software which has advantages but also disadvantages (Seibold, 2009). Since the ‘best’ solution has not been found yet, several countries like South Africa introduced programs that focus on the aim to close the gap to the knowledge economy and convert the country to a knowledge society (Akpor et al., 2011).

To get an answer in regard to the mentioned points, the paper will be structured as follows: The next section will focus on the knowledge economy as well as knowledge management and con-
tains a part about innovations and the measurement of the knowledge economy. The consequences of the digital divide will be analysed in the second section. There are three parts: knowledge and information asymmetries, innovations as well as the knowledge economy. The second-last section will be a discussion of some possible ways to bridge the digital divide, followed by the conclusion in regard to the main objectives of the paper.

**Figure 1: Causes, effects and ways to bridge the digital divide.**

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### Knowledge economy and knowledge management

To get a first overview about the topic and especially knowledge it is important to take a look at the knowledge economy and the related terms knowledge and knowledge management. Furthermore it is necessary to derive innovations as an outcome of several processes and interactions and to develop a possibility to measure the knowledge economy.

#### Knowledge economy

Digital divide has effects in the knowledge economy, since it is based on knowledge (Houghton & Sheehan, 2000). The three common known factors of production are land, capital and labour. This picture changes a bit in the knowledge economy, where the focus lies on knowledge which is the main production factor (OECD, 1996). Since the role of knowledge and information as factor of production evolved in the past, the production, management as well as the use of infor-
mation became more important (Houghton and Sheehan, 2000). Information could be broken down into bits and communicated as data (Davenport et al. 1998).

**Knowledge as an economic good**

Being one of the major factors of production, the importance of knowledge as an economic good increased in the past. This was mainly rooted in the increasing distribution of ICT and the Internet. It enabled the possibilities to gain, share as well as analyse knowledge and offered the possibility to achieve a competitive advantage because of the cheap way to transmit information (Houghton and Sheehan, 2000; OECD, 1996; OECD, 2000; The work foundation, 2006). Another reason was the increasing returns from investments in knowledge (OECD, 1996). Moreover, the number of Internet users as given in Figure 2 increased over time and will also do so in the future. Consequently, the importance of ICT and knowledge will also rise.

![Figure 2: Internet users 1993 – 2011 (World Bank, 2012a).](image_url)

Figure 2 can be enhanced by importing the world population as shown in Figure 3. As expected the number of Internet users as well as the world population is growing. In comparison, the number of Internet users grows faster in time. In the year 2005 the number of Internet users was nearly one sixth of the world population. Comparing the number of Internet users in 2010 with the number of people living on earth can be seen that the Internet users were up to nearly one third.

![Figure 3: Internet users and world population 1993 - 2010 (World Bank, 2012a & 2012b).](image_url)
In regard to knowledge as an economic good it would be interesting to determine the characteristics of this good. Considering scientific knowledge and even knowledge in general it can be assumed that knowledge is a public good. A public good can be characterized by non-rivalry and non-excludability which also fits the characteristics of knowledge (OECD, 2000). Whether this is the truth, depends on the kind of knowledge (OECD, 2000; OECD, 1996). Lundvall & Johnson (1994) distinguish knowledge in the forms given in table 1. Know-what is knowledge about facts like the ingredients of a product or geographically knowledge about a certain country. According to Lundvall & Johnson (1994) knowledge in this case is near to ‘information’ because it can be broken down into bits. The second form of knowledge is know-why. This type of knowledge was important for development in areas where scientific knowledge is needed. It is helpful to increase technological progress and the reduction of errors in trial and error processes. Know-who is knowledge about who can do what and who knows what. Know-how is knowledge in regard to skills.

Table 1: Forms of knowledge and what kind of knowledge it contains.

<table>
<thead>
<tr>
<th>Form of knowledge</th>
<th>Knowledge about</th>
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<tbody>
<tr>
<td>Know-what</td>
<td>Facts</td>
</tr>
<tr>
<td>Know-why</td>
<td>Scientific knowledge of principles and laws of motion in nature, the human mind and society</td>
</tr>
<tr>
<td>Know-who</td>
<td>Where to find/get knowledge</td>
</tr>
<tr>
<td>Know-how</td>
<td>Skills</td>
</tr>
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</table>

Know-what and know-why contain mainly observable knowledge. Know-how and know-who knowledge differ because of the tacitness of knowledge which is given with them. Therefore it could be stated that the higher the tacitness of knowledge is, the less knowledge is transferable (OECD, 2000). What all forms of knowledge have in common is that they have no real features of rivalry and that they are experience goods. Moreover, the level of exclusion depends on the kind of knowledge which is given (Sellens, 2009). In regard to this and the analysis of external effects it can be stated that know-how and know-what can cause direct and indirect network externalities (Sellens, 2009). Tacit knowledge on the other side can only cause learning network externalities (Sellens, 2009).

The fast development in the ICT sector and the growing amount of content that is transmitted through the Internet make it necessary to be informed about ICT and the information that could be found in the Internet and other media (Smith, 2002). Moreover, the growing amount of information that leads to learning can be found for example as content in the Internet or is generated by ICT. The result is a process of lifelong learning which is directly connected with the de-
development and use of ICT (OECD, 1996). This leads to the conclusion that an investment in ICT is also an investment in human skills and capabilities as they can be found in the ‘know-how’ form of knowledge (Houghton & Sheehan 2000). Therefore, the payment a worker gets is also a payment for his tacit as well as codified knowledge and the learning process by ‘learning-by-doing’ is another knowledge generating activity (Smith, 2002).

Wagner & Leydesdorff (2006) consider the production of knowledge within a network. In this network, the knowledge is shared and combined over boundaries which are bridged by the use of ICT. As stated by Proto et al. (2012) knowledge networks consist of three components which can interact with each other. These components are the generation, transfer and application of knowledge. The most interesting point in regard to this is the generation and use of knowledge which can be depicted by the changing picture of the innovation process (OECD, 1996). The former linear process which consists of research, development, production, and marketing changed into a complex structure with communication in and between every step as well as feedback loops (Kline & Rosenberg, 1986). This creates learning in-between the firm and is directly connected with lifelong learning which is mentioned in the previous paragraph.

**Knowledge in the context of globalisation**

The effects of globalisation are mainly the movement of entire firms or parts to other regions and a great opportunity to use the advantages of ICT (Rowthorn & Ramaswamy, 1998). Houghton & Sheehan (2000) state that capital flows increased more than trade did and that this is an indicator for the relevance of capital flows rather than trade for the given phase of globalisation. Moreover, they state that also the integration of financial and capital markets was important and led to capital flows between developed countries as well as from developed to developing countries. The role of the firm in this context is to face the new tasks and competition as well as to reorganize to encounter the upcoming challenges (OECD, 1996; Lorentzen, 2008). Another point in regard to globalisation and the changed aims of firms are new employment policies. Moreover, the OECD (1996) states that the globalisation could be the reason for a decreased demand in less-skilled workers.

**Knowledge management**

OECD (2000) defines knowledge management as management one form of capital that is for achieving the aims of an organization. Moreover, knowledge management includes the generation, transfer and use of knowledge (OECD, 2000; Jarboe, 2001). Additionally, Petrides (2004) states that the knowledge management process involves three areas: people, processes and technology. This seems to be a logical conclusion in regard to the knowledge management components: generation, transfer and use of knowledge. These components have to be operated by several persons, in several processes and by a technology that is able to do this efficiently. To achieve the organizational and economic aims of the company, the mentioned components and areas have to interact.

Sveiby (1997) distinguishes knowledge management into two tracks. The first one is the IT-Track knowledge management which aims at knowledge as an object which is organized by ICT. The
second track is the people-track knowledge management in which knowledge is handled as a process in which the aim is to evaluate, change and improve the knowledge of humans.

Davenport et al. (1998) take a look at the objectives of knowledge management by a study in which they reviewed 31 knowledge management projects. They are defining knowledge as information combined with context, experiences, interpretation and reflection. Their findings in regard to the objectives of the projects were that four of these were similar in all projects:

(i) Create knowledge repositories
(ii) Improve knowledge access
(iii) Enhance knowledge environment and
(iv) Manage knowledge as an asset.

By considering the explanation of Davenport et al. (1998) of these four types it is possible to get a connection to the tracks defined by Sveiby (1997) (Jarboe, 2001). (i) and (ii) have its focus on ICT as well as the organization and processes of knowledge in a more technical perspective. Additionally it has to be considered that Davenport et al. (1998) define knowledge repositories as a place where knowledge is stored and can be extracted on demand. These are for example competitive intelligence systems, documents or databases. The other two objectives (iii) and (iv) have their focus on the people. Managing knowledge as an asset thereby means on the one hand to manage the knowledge shared with other people that could be important for one party and on the other hand to manage knowledge-intensive assets like patents.

The following part will take a look at the three components: production, transmission and use of knowledge. The production or creation of knowledge will mainly happen by scientific or applied research which develops new knowledge (OECD, 1996). Scientific research is mainly done by universities and is called basic research which could handle knowledge as a public good (OECD, 1996). Applied research is done by firms and can be measured by the investments in research and development. This kind of research is not as basic as the scientific research and is therefore more connected to the industry and applications. A rough idea how the production of knowledge and mainly scientific knowledge developed in the past can be taken from the number of worldwide written journal articles. Mabe (2003) determines that the possibility to work in transregional groups leads to an increased number of journal articles as given in Figure 4. This is mainly rooted in the access to a greater variety of an increased amount of knowledge and the increased number of researchers. Additionally it is caused by the growing number of journals which came with the digitalization and the increasing number of researchers (Mabe, 2003).
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Figure 4: Number of journal articles world-wide (World Bank 2012d).

The transmission of knowledge aims at the education and training of scientists (OECD 1996). As already mentioned in the ‘Knowledge as an economic good’ chapter, learning is important in the knowledge economy. To be sure that the knowledge is produced and applied in the way it should it is necessary to have institutes that grant for this (OECD, 1996). The science system and mainly the universities are facing the role of being the main institutes for education of appropriate and qualitatively good knowledge. In conclusion, this could be stated as the educational missions of universities (OECD, 1996). As given in Figure 5, the number of researcher in R&D per million people in Europe increased over time. On the one hand, this is the result of the growth of the world population. On the other hand the growth of the importance of knowledge in the economy made it more important to invest in universities and other institutes that employ researchers or mentor them in groups (OECD, 1996).

Figure 5: Researchers in R&D per million people in Europe (World Bank 2012c).

The ‘use’ of knowledge is mainly expressed by the spread of knowledge in the society and knowledge as a problem solution tool (OECD, 1996; Petrides, 2004). OECD (1996) states that the role of ‘knowledge distribution networks’ as well as ‘national systems of innovation’ increases and that the science system is extremely important in regard to the transfer of knowledge.
Measuring knowledge economy

The main question regarding the knowledge economy is: How to measure the performance of the knowledge based economy? OECD (1996) explains the problem of defining indicators for measurements of the following points in the knowledge based economy:

(i) Knowledge inputs,
(ii) knowledge outputs,
(iii) knowledge stocks and flows,
(iv) knowledge networks, and
(v) knowledge and learning.

Batagan (2007) demonstrates the problem of the availability and quality of data as well as the problem of the creation of indicators to measure the performance of the knowledge based economy. OECD (1996) declares the following indicators:

(1) expenditures on R&D,
(2) employment of engineers and technical personnel,
(3) patents, and
(4) international balances of payments for technology.

These indicators allow a closer look on the knowledge based factors in the knowledge economy. Therefore they could make it possible to measure the performance of the knowledge based economy.

Innovation

According to these indicators it is possible to take a closer look at innovations. The production of knowledge is mainly done by research and development and therefore by investments in innovations (Shin, 2004). Fagerberg (2005) explains the differences between the terms invention and innovation and states that the transformation of an invention into an innovation by a firm needs the combination of several types of knowledge, skills and resources. Therefore the inventor differs from the innovator. Schumpeter (1934) states the following forms of innovations:

(i) introduction of a new good,
(ii) introduction of a new production method,
(iii) opening of a new market,
(iv) development of new source of supply,
(v) change in organisation.

Additionally, innovation can be distinguished in product and process innovations. A product innovation is the innovation of new goods and services (i), while a process innovation is an innovation in regard to the way goods and services are produced (ii) (Fagerberg, 2005). Moreover, it is possible to distinguish between radical and incremental innovations. Radical innovations on the one hand are changes in technology that are new and differ from the existing technologies. In-
Incremental innovations on the other hand are small changes in existing technologies (Popadiuk & Choo, 2006).

The picture of innovations changed over time from the linear process which consists of research, development, production and marketing to the chain-linked model by Kline & Rosenberg (1986). The innovation process in the chain-linked model is more dynamic, more complex and consists of feedback loops (f) within the processes (c) (see Figure 6) (Kline & Rosenberg, 1986). The starting point is the identification of a potential market and not the research as it is in the linear model.

Besides the definition and basic facts of innovation it is interesting to take a look at the way innovations are made. Concerning Schumpeter (1934) the person who is innovating needs some entrepreneurial skills. These skills, knowledge and characteristics enable a person to find new solutions for existing problems. In regard to firms it is important to follow a path but to avoid being locked-in into a path which could lead to problems in regard to path-dependencies (Fagerberg, 2005). The speed of innovation could be enhanced by certain techniques. Jarboe (2001) states that knowledge clusters, which exchange and gain local tacit knowledge by several knowledge management techniques, enhance the innovation speed of firms. Mainly the large
firms are in competition in regard to innovations. Therefore, the speed of innovations and the intension of R&D are important factors in regard to the ability to gain advantages in competition (Gerybadze, 2003). Moreover, the technology, different locations, interaction, knowledge exchange and therefore ICT play a larger role in regard to innovation than they did in former times (Gerybadze, 2003).

The analysis by Arrow (1962) in regard to market forms and innovation incentives leads to the conclusion that innovation makes sense in perfect competition and when the innovation is radical. Monopolistic competition does not lead to better results in regard to innovation than perfect competition (Arrow 1962). Moreover, patents as a restriction of the appropriation of information and intellectual property rights (IPR) in general play a positive role in regard to the incentives to invest in R&D and to innovate (Arrow, 1962; Withers, 2006). Scherer & Ross (1990) analysed the situation on the market for innovation in regard to the innovation and imitation dates with the assumption of n-firms and no or weak patent protection. The result is that the innovation process is accelerated by an increasing number of firms but this can draw into a negative situation for all firms. The latter happens if there are too many firms and this acceleration process leads to an unprofitable solution.

Taking all this into account it can be stated that R&D and innovations are an important factor in the knowledge economy. Moreover the detailed processes are difficult to define and to measure. There is a big impact of education, knowledge, learning and knowledge management on innovation. Given this fact, the ability to combine certain skills, knowledge and resources can lead to a real advantage in regard to other countries.

**Consequences of the digital divide**

**Digital Divide**

To get a first impression of the impact of the digital divide on knowledge management, the knowledge economy, and innovations it is useful to characterize the digital divide first. When considering the term ‘digital divide’ the two words digital and divide come into attention and lead to the guess that the digital divide is mainly a problem of the allocation of digital systems in the society. This is a finding in regard to Evers & Gerke (2004) who refer to the digital divide as the technological aspect of the knowledge gap. Lloyd Morrisett, the former president of the Markle Foundation, is often called the first person who mentioned the digital divide as a gap between information ‘haves’ and ‘have-nots’. He gave a basis for a direct relation of ICT and the spread of information in the society (Hoffmann et al., 2001). In the view of Sutton (2007) the digital divide is mainly given by the different possibilities of access to the Internet. This is directly correlated with the access to computers and other ICT because access to the Internet is not possible without them.

Digital divide is not only important in our ‘modern’ society, but also in regard to the developing countries which was mentioned by Braga (1998), who exhibits the role of ICT in regard to the
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gap between developed and developing countries. Additionally, in developing countries themselves it is possible to find a digital gap. In conclusion to the first impression of digital divide it is possible to state that this phenomenon related to different access to ICT can be found in nearly all societies all over the world and also between a large number of societies.

Seibold (2009) breaks down digital divide into innovation divide and learning divide. On the one hand, learning divide in this context refers to the ability to use the content given via the Internet. On the other hand, it refers to the ability to use ICT, software, e-Learning and other means to get access to information. The innovation divide is the consequence of the knowledge and learning divide (Seibold, 2009). Innovation divide means the problem of facing the challenges of fast innovation processes with short innovation periods and faster changing knowledge.

Consequences
After explaining the term digital divide it is also important to take a look at the consequences of the digital divide. As given in Figure 1 there is at first less access to information and, therefore, less possibility to gain further and latest knowledge for those who have a weaker access to ICT (Evers & Gerke, 2004).

Knowledge and information asymmetries
The knowledge and information in the society differ among individuals (Hayek, 1945). Given knowledge therefore is different from individual to individual and also in different regional areas (Cooke, 2005). Furthermore, the ability of people in different areas to produce, transfer and use knowledge differs and is dependent on certain characteristics (Fritsch & Franke, 2004). The digital divide and therefore the distribution of ICT affect the spread, access and communication of knowledge (Evers & Gerke, 2004). This happens because people who have access to ICT can gain and communicate their knowledge in a very fast way. People who do not have this possibility have to use other ways which might be slower or less effective because of the missing option to reduce the information asymmetries.

Taking this into account it is also possible to assume that evolutionary processes in science will not be as fast as they are in countries or regions with a higher access to ICT (Hayek, 1945). Knowledge will be updated later and therefore ‘older’ theories will prevail longer and may lead to less efficiency and therefore a slower development (Hayek, 1945). There is a rise of ICT usage in developed countries and also in developing countries. By taking this into account it must also be mentioned that there is a higher share of population using ICT but also a widening gap between rich and poor and the digital divide will grow (Evers & Gerke, 2004). The reason for this development is the higher share of intellectual property rights and patents, which makes it difficult for people to produce, use or transfer knowledge. Besides, the digital divide in regard to knowledge asymmetry also affects the next generations. Missing access to ICT and missing knowledge in combination, leads to a disadvantage in learning, teaching and the circulation of knowledge (OECD, 2000). This leads to a disadvantage in regard to other regions or countries which are more able to manage their knowledge and have higher access to ICT (Evers & Gerke, 2004).
Countries with less access to ICT have less access to global information and knowledge. This leads at first to a disadvantage in regard to the process of informing and new findings in nearly all areas (Kim et al., 2009). By taking this into account it could also be stated that weaker access to ICT leads to more communication costs and this has an impact on trade (Fink et al., 2005). Also in regard to that it could be stated that the access to ICT and the Internet leads to an improvement of infrastructure in regard to trade and therefore to advantages for people with higher access to ICT (Wheatley & Roe, 2005). Both findings lead to the conclusion that the process of informing is more costly and the gaining of information is more difficult for people with weaker access to ICT. In regard to that it could be stated that a lack of information, higher costs and a lack of infrastructure in regard to trade lead to disadvantages (Thiemann et al., 2012).

The second disadvantage occurs for those countries that do not have the ability to access the knowledge of the countries that are not able to share their knowledge because of missing ICT. Another consequence of the given asymmetry is that there exists an uncertainty about the knowledge that is undiscovered and that is already forgotten and therefore may not be accessible for either party on both sides (Bawden, 2004). This phenomenon affects both sides but it could be expected that the problem is also worse for the side which has access to the ICT. This seems not to be the point on a first view but thinking again about it leads to the following conclusion: Having access to ICT leads to the ability to save information, knowledge and to manage knowledge in a more efficient way than having no access to ICT. People without or with only weak access to ICT do not have this opportunity or at least not in this efficient way. Therefore the loss of knowledge is caused by the fact that people carrying this knowledge are dying or leaving the area, forgetting it by accident or through for example changing traditions or environments (Swanson, 1986). Another very hypothetical idea could be that the people who had weak or no access to ICT could have been able to solve a given problem but did not have the means to do so. This is another problem caused by the digital divide.

**Digital divide and Innovations**

As already mentioned in the last paragraphs the role of knowledge and information is important in a society. Basic research is mainly done in universities and these are therefore playing an important role in regard to innovation (UN Millennium Project 2005, 2005; Sachs, 2003). The digital divide causes another form of divide in regard to innovation. This is the aforementioned ‘innovation divide’. Seibold (2009) states that the innovation divide in development countries could be divided into the language divide, content divide and a third divide that could be described as intellectual property divide. The language divide contains the disability of people to speak the language that is needed for content given in the Internet and therefore the disability to take part in innovation processes in the Internet. Another point in regard to this is that a person who does not speak the language of others who want to cooperate with him or her is not able to communicate and therefore to cooperate. This could be stated as a real disadvantage in regard to research and development cooperation.

The second point mentioned by Seibold (2009), the content divide could be described as the not-present knowledge which is a barrier for innovations. This, on the one hand, refers to re-
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gional knowledge and the missing access to global knowledge and, on the other hand, to the problem in regard to understanding the given knowledge because of different languages or not-present pre-knowledge in the given area. This leads to a lack of provision of knowledge from people, universities and other institutions and therefore to a lack of innovations because of missing ‘input’ to innovate and to cooperate (Lester, 2005).

The last mentioned point by Seibold (2009) is the in this paper called intellectual property divide. This divide is directly connected to patents and their role in regard to the lock-in of developing countries into a certain technology level. This is rooted, for example, in the disability to invest and to pay the fees for licences which leads to a state were only old or no technology or software at all is present. Another point with regard to the use of technology of other countries is that there may be no opportunity to use this technology in another area because of the high specificity of the technology (Sachs, 2003). By combining this with the lack of knowledge it is possible to conclude that this technology will not be used in the developing countries because these countries are not able to a) invest in a technology b) use it and c) transform it into as usable technology for them.

These are only a few problems in regard to digital divide and innovations which exists in developing countries. As already stated one problem is the not-present possibility to work together with other scientists or people to reach a certain goal. This point is not only important in regard to the human–human relationship but also for the cooperation and interaction of universities (or other institutes doing basic research), firms and the government in regard to the innovation process (Sachs, 2003). If these institutions are not able to cooperate because of missing ICT, in consequence it leads to missing innovations and therefore missing economic possibilities (Gerybadze, 2003). Moreover, as stated by Gerybadze (2003) a consequence of the digital divide is the missing ability to exchange information and also the missing cooperation and coordination.

In conclusion, in regard to innovation it could be stated that the role of universities for basic research is important. Moreover, universities play an important role in regard to education and the spread of knowledge as well as the creation of new knowledge (Lester, 2005). Besides, universities are one driver for the ability to solve problems, cooperation and interaction. The lack of ICT and the consequences for the universities lower the abilities for developing countries to innovate. Another important point refers to patents and other intellectual property rights, which could be a large barrier for the adaption of knowledge and the development of further knowledge. There is an economic disadvantage on the one hand because of missing capital to pay licences or to buy certain patents and on the other hand because of the disability to use and capitalize own patents in an effective way.

Digital divide and the knowledge economy

Another point caused by the digital divide and therefore the unequal distribution of ICT is that it is a barrier for development (Sutton, 2007). As given in the study of the United Nations Conference on Trade and Development (UNCTAD, 2006) there is a positive correlation between the access to ICT and economic growth. ICT plays a major role in regard to the efficiency of the
economy and the access to knowledge becomes more and more global because of the spreading through the Internet (Seibold, 2009). Mainly productivity of individuals and firms is affected by the access to ICT (Coenen & Riehm, 2009). This leads to the conclusion that the digital divide increases the gap between developed and developing countries.

As already stated in the previous paragraph a weak access to ICT has a negative impact on innovations (Seibold, 2009). A measurement of the amount of innovations could be done by comparing the amount of patents. As stated in the ‘Measuring the knowledge economy’ paragraph this is one indicator for the knowledge economy. To get an impression of the difference between countries which have a nearly equal number of inhabitants, it is worth to take a look at the Republic of Korea and South Africa. Both countries have nearly 50 Million inhabitants, but the applications of patents in 2010 differ significantly (WIPO 2011). The number of patent applications of residents and non-residents in South Africa was 6,383. Compare with 170,101 applications made in the Republic of Korea in the same period. It is patent applications in the Republic of Korea exceed by far those made in South Africa (WIPO, 2011). The Republic of Korea was the leader in ICT access at the beginning of the century and stabilized the number of Internet and ICT users in regard to the population size. The big impact of ICT in the Republic of Korea was driven by a variety of programs with the aim on the development of an information society (Ovum Consulting, 2009). South Africa is on its way to become a country participating in the global knowledge economy and has several programs to overcome the lack of ICT and other barriers for development (Akpor et al., 2011).

Taken this evidence and the fact that knowledge and therefore innovation have an impact on the growth of societies and economies it is possible to state that there is an impact of the accessibility to ICT on economies. Moreover, it is possible to get an impression about the magnitude of this impact by the indicators given in the previous paragraphs and with the example given in this paragraph.

**How to overcome the digital divide?**

As shown in Figure 1, there are several possibilities to overcome the digital divide and the other forms of divide like the knowledge, learning and innovation divide. For example, South Africa has a complex plan called the Information Society and Development (ISAD) Strategic Plan 2010-2013 which aims at the improvement and acceleration of the growth. The Department of Communication plan is divided into several strategic goals:

- maximisation of investments in the ICT related sector,
- create and improve the ICT infrastructure to satisfy the needs of all participants,
- improve access and usage of ICT,
- building a developmental state and improve public services and democratic institutions,
- push ICT state owned entities,
- contribute to the global ICT agenda,
- building an information society to improve the socio-economic development.
The new Strategic Plan 2012 aims at the creation of a world class ICT environment. The goals to reach this aim did not change (Department of Communications, 2012). The assessment of the current situation of South Africa is that they see themselves in a lack of access to mobile broadband. Furthermore they lost their leader position in regard to Internet and broadband connectivity which seems to be mainly a problem of pricing these products. The access to broadcasting means like television and radio is quite good but there is a lack of access, acceptance and usage of ICT (Department of Communication, 2012).

The Republic of Korea on the other side used several plans and programs to make its way to a knowledge and information economy (Ovum Consulting, 2009). One of these was the promotion of the broadband market which was made by several policies:

- Master plans to develop an information society,
- Finance projects which aim at the use of information,
- infrastructure and applications development policies,
- Content promotion policies,
- Improvement of industrial policies,
- Regulation policies in regard to the broadband market (Ovum Consulting, 2009).

Ovum Consulting (2009) describes these as follows: The infrastructure and application development policies aimed at the introduction of an advanced information infrastructure. This mainly consists of communication networks, Internet services and ICT applications. Moreover policies were included to provide broadband access to an enhanced number of people. The purpose of the content promotion policies was to overcome the problem that the Korean language is not spoken by many people outside of Korea. The main result of this issue was that the content delivered by Korean people was not as successful as the hardware sector was. The aim of the policies was to become a top five content producer. The improvement of industrial policies happened for example by the promotion of R&D in ICT and international collaboration in research. Another point of the industrial policies was the support of the growing Internet sector by economic cost reduction through lower tax and rents as well as the promotion of ICT in traditional industries.

Since these policies aimed at the supply side, the demand side had its own program with the aim to improve the use of ICT and broadband in business, e-learning and private areas. The major difference in regard to South Africa is that the Republic of Korea has a higher average income and therefore is more able to purchase the necessary products (Akpor et al., 2011; Ovum consulting, 2009).

The main question is whether these policies can help other developing countries to enhance the use of ICT in the private and in the business area. This does also depend on the income and the market for ICT and especially the demand for ICT and their usage. In case that there is not
enough income, demand and possible space for usage of ICT, the role of the state becomes more and more important. The first idea in regard to that would be a program that has the focus on the improvement of access to ICT at a lower, regional level and the enhancement of this access in later phases of the program. Whether this would be successful or not cannot really be predicted. Examples like the Republic of Korea show that state imposed programs that help a big variety of people are useful to and lead to a good outcome.

There are also some ideas that are not directly related to countries and are therefore more general than this. Some of those ideas are discussed in Sharma & Mokhtar (2008). This idea to bridge the digital divide consists of three pillars to proceed to an information society. These pillars are the promotion of an ICT infrastructure, the access to information and knowledge and the building of capability and confidence. Also, Seibold (2009) mentions open access to hardware, software and content that is important for the developing country to overcome the digital divide.

Ruggie & Dossal (2000) state that investments, micro lending, knowledge management, access to the Internet, information and knowledge as well as education need to bridge the digital divide. Gunasekara (2006) discusses the role of universities in regard to the development of regional innovation systems. Moreover, Ruggie & Dossal (2000) describe the role of the United Nations as provider of strategies and projects, connector between different parties as well as provider of aid and investments in developing countries. Additionally, Sachs (2003) takes a global perspective and discusses a way to integrate the economies into the world production. Sachs (2003) also suggests financial aid and other means to overcome the digital divide. The importance of wireless technologies and e-Learning in regard to bridging the digital divide is discussed by Smyth (2006). The next parts of this paragraph will take briefly a closer look at two proposed solutions: open source and open innovations.

**Open source**

The open source concept is mainly known owing to the Linux operating system. It has both advantages and disadvantages. Advantages are that those programs are inexpensive or costless and accessible. This is a big advantage for developing countries and especially the regions and people who do not have the income to buy expensive software licences (Fucks & Horak, 2006; Free Software Foundation, 1996; Ghosh, 2004). Open source can also lead to other positive effects, such as like strengthening the ability to solve problems, generate the ability to work on new software and gain the skills to innovate new or improved software (Gosh, 2004; Tirole & Lerner, 2002). Moreover, open source offers the opportunity to work on research projects with software that is maybe not the best in class but good enough to have a good outcome and is similar to commercial software (Lungo & Kaasbøl, 2007).

The advantages of open source are obviously present, but they may be overshadowed by the disadvantages. In regard to developing countries one already mentioned problem is the language and the ability to learn or better the possibility to learn certain things. Additionally, open source software is not in every case the easiest to understand, which leads to use problems. For
Lungo (2006), the problem is that the software is designed for a certain purpose rather than for programmers’ use.

Open source is one tool of many needed in overcoming the digital divide. It enables developing countries to take part in research, the Internet and other forms of information or knowledge usage which is done through the computer. Moreover, open source enables the use of programs that help people to improve their work and make the life easier. Problems in regard to the understanding and difficulty of the open source software might be overweight by the advantages of cost savings and an increasing compatibility.

**Open innovations**

The concept of open innovations is directly connected with the characteristics of the knowledge economy. Since knowledge is widely spread through the Internet and other channels, it could be useful to take this into account and make others participate in one’s own innovation process. This happens mostly in firms through open innovation (Kuhlen, 2006). This means that information could be provided by the firm or outsiders and is combined into new products, processes or ideas (Chesbrough, 2006). This seems to be the realization of knowledge networks and is already done in R&D Joint Ventures. This is not the case, since open innovation differs from knowledge networks because of the ‘openness’ of the innovation process which leads to a great variety of information and knowledge.

Open innovation itself seems to be more beneficial for the firms which allow others to participate in their innovation process and therefore save R&D costs. This is one side. The other side is that others, such as developing countries, are able to participate in the innovation process. Participating people are able to gain new knowledge, skills and contribute their otherwise potentially lost knowledge, in an innovation process that could lead to a useful outcome. These skills are not only the skills of sharing knowledge or using information. The new gained knowledge could rather be about the structuring of research and development as well as the needs and tools to realize own ideas (Burmeister et al., 2006). Since the gained knowledge would have a beneficial effect for both developing and developed countries, open innovation could be really useful for developing countries. It seems that open innovations are not the best solution for those who have no access to ICT since it is difficult for them to take part in this innovation process. Moreover, open innovations do not create directly an opportunity to bridge the digital divide. Rather, they create an opportunity to gain new knowledge, bridge the knowledge and language divide, and to gain further means, tools and ideas that can lead to bridging the digital divide.

**Summary and Conclusion**

The first objective of this paper was to discuss relationships between knowledge, knowledge economy, knowledge management and the role of innovations. Knowledge is an important factor in the Western world and the knowledge economy as a whole. Moreover, knowledge is understood as an economic good that has certain forms. Knowledge production, use and transfer
play an important role in modern societies. Measurement of the knowledge economy is possible but it is connected to a variety of different indicators which are sometimes difficult to estimate. Innovations and their role in the knowledge economy could be characterized as follows: innovations involve a complex, dynamic process that requires an interplay of a variety of different institutions and people.

The second objective was to explain the digital divide and some of its consequences in regard to knowledge and information asymmetries, knowledge economy and innovations. Digital divide could be divided into several categories, such as learning divide and innovation divide, as Seibold (2009) has suggested. The consequences in regard to knowledge and information are mainly the asymmetric knowledge and information basis and therefore the problems in regard to knowledge management, research and development, innovations and the access to the Internet content. The role of already lost or not explored knowledge in this context is interesting and leads to the need for further collection of knowledge and information. The impact of the digital divide on innovations is mainly shown in the language divide, content divide and the here-named intellectual property divide. These divides mainly cause the innovation divide and lead therefore to a lack of capability to innovate. Moreover, university, as an institution for creation and dissemination of knowledge, is an important factor that influences the capability and possibility to innovate. The effects on the knowledge economy are shown on the case of South Africa and the Republic of Korea. The case suggests that a smaller access to ICT has an impact on the economy and on the volume of patent applications.

The third objective of the preceding discussion was to answer the question: How the digital divide could be bridged? The case of South Africa and the Republic of Korea indicates that the income is a very important factor for developing an information society, which has worked in favour of the Republic of Korea. In contrast, South Africa’s situation is still characterized by plans and strategies of reaching an information society rather than tangible deliverables. Open source and open innovation create opportunities for bridging the digital divide. The problem is that ICT are necessary, which disadvantages developing countries.

In conclusion, it could be stated that the digital divide affects nearly all people at all levels of society. The winners and losers are in most cases easy to detect. Still, it could be argued that we all are winners and loser. One of the major aims in today’s society should be to bridge the digital divide and to make people able to participate in a great network of ideas, knowledge and information. Another aim should be to improve their ability to communicate, and to produce, use and transfer knowledge. As discussed above, one goal should be to gain further knowledge about processes and products in order to overcome the digital divide. This is the global and national challenge for most of the developing countries in the upcoming years.

The major findings in this work are that the digital divide creates a knowledge and information asymmetry and, therefore, hurts the information and knowledge exchanges as well as the production and use of knowledge. Exchange and access to knowledge is important in regard to innovation processes. The effect of the digital divide on innovation is clear. The gap could be
closed a little bit by the use of open innovations for generating new and using existing ideas. The major problems concerning innovation are the language, content and intellectual property divide. Furthermore, the disability of people to cooperate and communicate leads to a lack of innovation and, therefore, to less growth than possible. The effect on the countries, therefore, is given by the lower growth and the disability to participate in the world market for knowledge. Open innovations and open source are two solutions for bridging the divide.

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Digital divide, knowledge and innovations


Digital divide, knowledge and innovations


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**Biography**

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