

The adaptation of the radiologic technician to new technologies*

A adaptação do técnico de radiologia às novas tecnologias

Célia Maria Ferreira Felício¹, Vitor Manuel Costa Pereira Rodrigues²

Abstract **OBJECTIVE:** The present study was aimed at evaluating radiologic technicians' capacity to adapt to new technologies, besides investigating which factors could be related to the implementation of new technologies and to identify some of its possible advantages and disadvantages as well. **MATERIALS AND METHODS:** The present descriptive and cross-sectional study evaluated data collected by means of a structured questionnaire divided into four components: sample characterization, evaluation of the opinion about new technologies, information system satisfaction scale, and scale of overall assessment of information systems. Data anonymity and confidentiality were assured. The sample included 58 radiologic technicians working at healthcare institutions of Trás-os-Montes and Alto Douro, Portugal. **RESULTS:** The data have allowed the author to observe that all the technicians were unanimous in considering that new technologies represent important and useful tools in their daily activity, with advantages in terms of facility to access the patients' radiological data, decrease in data loss, faster examinations and data accuracy. **CONCLUSION:** In general, one can conclude that radiologic technicians could satisfactorily adapt themselves to new technologies implemented in their respective departments.

Keywords: Radiology; Technological development; Adaptation.

Resumo **OBJETIVO:** Pretendeu-se avaliar a capacidade de adaptação dos técnicos de radiologia às novas tecnologias, avaliar os fatores relacionados com o processo de implementação das novas tecnologias e conhecer algumas vantagens e desvantagens identificadas pelos técnicos de radiologia. **MATERIAIS E MÉTODOS:** Tratou-se de um estudo descritivo e transversal. Os dados foram recolhidos através de um questionário estruturado em quatro componentes – caracterização da amostra, avaliação da opinião acerca das novas tecnologias, escala de satisfação com a utilização de sistemas de informação, e a escala de avaliação geral dos sistemas de informação –, tendo sido garantidos o anonimato e a confidencialidade dos dados. Participaram neste estudo 58 técnicos de radiologia a exercer funções em instituições hospitalares da região de Trás-os-Montes e Alto Douro, Portugal. **RESULTADOS:** Os resultados obtidos permitiram-nos constatar que a totalidade dos técnicos afirma que a nova tecnologia é vista como uma ferramenta de trabalho com utilidade para a sua atividade profissional, sendo que as vantagens da implementação das novas tecnologias refletem-se na facilidade de acesso ao arquivo radiológico do usuário, na diminuição da perda de informação, na rapidez de execução dos exames e no rigor dos registos do usuário. **CONCLUSÃO:** Podemos dizer, de uma maneira geral, que os técnicos de radiologia se adaptaram de uma forma muito satisfatória às novas tecnologias implementadas nos seus departamentos.

Unitermos: Radiologia; Desenvolvimento tecnológico; Adaptação.

Felício C, Rodrigues V. The adaptation of the radiologic technician to new technologies. *Radiol Bras.* 2010;43(1):23–28.

INTRODUCTION

Today there is widespread consciousness that the world is in the age of information, knowledge and globalization. An increasingly global economy implies

greater challenges and demands for organizations, as well as constant changes at faster speed. The organizations have to adjust to this reality in order to remain competitive and to maintain their ability to provide quality services^(1,2). One of the challenges posed by the modernization of the health system lies on the more intensive

utilization of information technologies as a strategic investment, capable of promoting the rationalization of the use of available resources and increasing efficiency and quality. In the current context of profound transformations, one of the key factors is the capability to organize multiple and scattered data into a useful set of indicators that allows the rigorous management the health system as a whole in a scenario encompassing process efficiency and quality of information⁽³⁾.

Information systems for the management of images and clinical data first ap-

* Study developed at Universidade de Trás-os-Montes e Alto Douro, Portugal.

1. Master of Management of Health Centers, Radiologic Technician at Centro Hospitalar de Trás-os-Montes e Alto Douro, Unidade de Vila Real, Portugal.

2. PhD of Biomedical Sciences, Coordinator, Professor, Integrated Member of Center of Research in Sports, Health and Human Development (CIDESD), Universidade de Trás-os-Montes e Alto Douro, Portugal.

Mailing address: Dr. Vitor Manuel Costa Pereira Rodrigues. ESEnf. – Universidade de Trás-os-Montes e Alto Douro. Lugar do Tojal - Lodelo 5000-232 Vila Real, Portugal. E-mail: vmcpr@utad.pt

Received August 22, 2009. Accepted after revision November 3, 2009.

peared late in the eighties, when the digital acquisition systems started being deployed in large scale at hospitals. At that time, each equipment was considered as a separate system, connected only with its workstation and with a determined printer⁽⁴⁾.

The radiological film has served radiology for over 100 years with excellent results, in the images acquisition, visualization and storage. The developments of conventional radiology have led to the system comprising film + intensifier screen, which, in association, originated the images acquisition, visualization and also data storage⁽⁵⁾.

The introduction of devices that allow the acquisition of digital radiological images without the utilization of films, in association with the current computer capabilities and other means, has originated the digital radiology.

At the end of the last century, particularly over its last decade, due to developments in the information technology, alternative solutions for the use of films started being developed. The picture archiving and communication system (PACS), or a digital storage and communication system for medical images, has emerged as the alternative to replace all the film-based structure, both at the functionality and utility levels, originating the digital radiology concept, with the main and subjacent idea that, in this context radiological films would not be produced anymore⁽⁶⁾. The digital techniques in radiology are still partially in the works in progress stage. Digitizing means transforming analog data into numerical data⁽⁷⁾. In digital radiology, the image acquisition, visualization and data storage are independent components. Thus, the image is acquired, the data are sent to a computer which, after processing the data, sends them to an appropriate monitor to be visualized, or to one of the available storage systems. The most immediate advantage in this process is the digital system capability of previously manipulating the data, in such a way to optimize the image visualization and storage⁽⁵⁻⁷⁾.

Teleradiology is clearly the most relevant area of telemedicine both in Portugal and worldwide. Teleradiology is the electronic transmission of radiological

images and clinical reports from one location to another, for later interpretation and reference⁽⁸⁾. This type of technology allows health system users a greater accessibility to differentiated medical care, a higher diagnostic quality, faster information on the user health and reduction in costs. For the health institutions and professionals the advantages in the implementation of such technology include the centralization and optimization of complex activities, the decrease in the geographic isolation impact, swiftness in the diagnosis health care decentralization, improvement in the diagnosis quality through the exchange of experiences, and the possibility of distance medicine teaching⁽⁹⁾.

Thus, and considering that the introduction of new information technologies in the field of Imaging Sciences determines a profound redefinition of the radiological activity both at the architectural level and in terms of tasks distribution, the present study was developed with the objective of evaluating radiology technicians adaptability to the new technologies as well as the factors that may be related to the process of implementation of such technologies, and analyze some of the advantages/shortcomings identified by the radiology technicians.

MATERIALS AND METHODS

The present descriptive and cross-sectional study included 58 radiology technicians working at Centro Hospitalar de Trás-os-Montes e Alto Douro and Centro Hospitalar do Nordeste in the region of Trás-os-Montes and Alto Douro, Portugal.

Data collection was made by means of a four-section structured questionnaire. The first section comprised five questions aimed at characterizing the sample. The second section was composed of nine questions aimed at evaluating the technicians' opinion about the implementation of new technologies and their advantages/disadvantages. The third section was composed by a scale of "satisfaction with the utilization of information systems" (SUIS)⁽¹⁰⁾. Such scale is composed by nine items, and is a Likert-type five-point scale, where 1 corresponds to zero and 5 corresponds to very high. Thus the maximum score is 45

points, and the higher is the obtained score, the higher is the SUIS. As regards the analysis of the SUIS internal consistency, the Cronbach's alpha corresponds to 0.85. The fourth section is composed by a scale of "general evaluation of the information systems" (GEIS)⁽¹⁰⁾. This scale comprises six items. It is a Likert-type four-point scale, where 1 corresponds to totally inappropriate, and 4 corresponds to very appropriate. The maximum possible score is 24 points, and the higher is the score, the better is the GEIS. As regards the Cronbach's alpha was 0.75.

The data collection was previously approved by the Council of Administration of Centro Hospitalar de Trás-os-Montes e Alto Douro and of Centro Hospitalar do Nordeste. The technicians participating in the study were given an explanation on the research foundations and objectives, as well as on the criteria of data confidentiality and anonymity, and signed a term of free and informed consent.

The data were processed by means of the software Statistical Package for the Social Sciences (SPSS-version13.0). For such purpose, relative frequencies, mean and standard deviation were utilized, and the data were analyzed by means of the Student's *t*-test and analysis of variance ANOVA I. The adopted level of statistical significance was $p < 0.05$.

RESULTS

Among the 58 technicians included in the present study population, 41 (70.7%) were women and 17 (29.3%) were men. The Student's *t*-test demonstrated statistically significant differences ($p = 0.003$) between genres and SUIS only in relation to adaptability to new technologies. However, men presented a higher mean in relation to GEIS (Table 1). Therefore, one can conclude that the female technicians had more difficulty in the utilization of information systems.

With respect to age, the mean age among the radiology technicians was 39 years (age range: 22 to 59 years). Most of the technicians (51.7%) were in the age range between 31 and 40 years. The group in this age range corresponded to 22.4% of the study population. The remaining groups

with ages < 31 years and > 50 years represented, respectively, 12.1% and 13.8% of the study population. The analysis of variance ANOVA I demonstrated statistically significant differences ($p = 0.033$) only between age groups and SUIS in relation to the technicians' adaptability to new technologies. It is important to observe that the age group between 51 and 60 years presented the highest mean both in relation to the SUIS and to GEIS (Table 2).

Regarding years in service, the time ranged from a minimum of 1 year to a maximum of 37 years (mean, 14.5 years). Most of the technicians – 32 (55.2%) were in the interval from 11 to 20 years of service. The level of adaptability to new technologies of the technicians with more years in service was analyzed by means of the ANOVA I that demonstrated no statistically significant difference as far as years in service, SUIS and GEIS are concerned. However, technicians with more years in service (31–40 years) presented highest means for SUIS (34.1) and for GEIS (17.9) (Table 3).

For the greatest majority of the technicians, the new technology is seen as a useful working tool for their professional activity. Among the 58 technicians, 52.1% consider the new technology as extremely useful, 32.8% as very useful, and 5.2% as reasonably useful. With the purpose of investigating whether the knowledge on information technology acquired before the deployment of the new technology contributed for the individual performance in this system, the authors observed that the majority responded favorably. Among the 58 technicians, 23 (39.7%) responded that it contributed very much, 15 (25.9%) responded that it contributed reasonably, 10 (17.2%) responded that it contributed much, and 10 (17.2%) responded that it contributed little. As regards the relation between the previous knowledge on information technology and the SUIS and GEIS, no statistically significant difference was observed. However, those technicians that considered that such knowledge contributed to their performance in the system, presented highest means for SUIS (31.5) and for GEIS (17.6).

The utilization of the new technology is seen as a motivating factor, considering the responses regarding this topic, with the

Table 1 Means and respective standard deviations of SUIS and GEIS according to sex.

	Sex	n	Mean	Standard deviation	t	d.f.	p
SUIS	Male	17	34.2	5.4	3.121	56	0.003
	Female	41	29.8	4.7			
GEIS	Male	17	18.3	2.7	1.914	56	0.061
	Female	41	17.2	1.7			

n, sample number; d.f., degrees of freedom.

Table 2 Means and respective standard deviations of SUIS and GEIS according to age group.

	Age group	n	Mean	Standard deviation	F	p
SUIS	20–30	7	29.0	3.1	3.131	0.033
	31–40	30	32.2	5.5		
	41–50	13	28.2	4.2		
	51–60	8	33.6	5.5		
GEIS	20–30	7	17.3	1.6	1.088	0.362
	31–40	30	17.8	2.1		
	41–50	13	16.7	1.8		
	51–60	8	18.0	2.3		

n, sample number; F, ANOVA test value.

Table 3 Mean and respective standard deviations of SUIS and GEIS, according to years in service.

	Years in service	n	Mean	Standard deviation	F	p
SUIS	1–10	13	31.1	5.2	1.129	0.346
	11–20	32	30.9	5.2		
	21–30	6	29.0	5.3		
	31–40	7	34.1	5.3		
GEIS	1–10	13	17.7	2.1	0.165	0.919
	11–20	32	17.4	1.9		
	21–30	6	17.2	2.5		
	31–40	7	17.9	2.4		

n, sample number; F, ANOVA test value.

following results: 43.1% very much, 27.6% much, 27.6 reasonably and only 1.7% little. The Student's *t*-test demonstrated that there was no statistically significant difference between professional motivation and the SUIS and GEIS. It is important to note that the technicians with highest professional motivation after using the new technology, presented highest means in relation to SUIS (31.2) and GEIS (17.5).

With respect to the responses regarding advantages of the deployment of the new technology, some subcategories emerged as follows. Table 4 demonstrates that, the advantages related to efficiency are most frequently mentioned, followed by advantages at the technical level. So, at the efficiency level, the greater facility of access to the users' radiological data file and the

decrease in data loss are highlighted. At the technical level, the most frequently mentioned advantages were the swiftness of examinations and the accuracy in the users' data records.

With regards to disadvantages in the implementation of the new technology identified by the technicians, subcategories emerged as shown on Table 5. The disadvantages at the technical level were most frequently mentioned by the technicians, followed by disadvantages at the efficiency level. In the first subcategory, the most frequently mentioned disadvantages were the increase in time spent in the examination, i.e., the examination takes longer to be completed, and the automation of tasks. In the second subcategory, the most frequently mentioned disadvantage was the

Table 4 Advantages in the implementation of the new technologies.

Category	Subcategories	Subject	Number of mentions
Advantages	At the technical level	Swiftness in examinations	17
		Greater responsabilization	4
		Planning of activities	3
		Accuracy in patient records	14
	At the economic level	Greater productivity	8
		Material cost reduction	8
		Reduction in use of paper	5
	At the level of services provided	Decrease in radiological exposure	7
		Decrease in access time	4
	At the efficiency level	Decrease in data loss	14
		Greater swiftness in image availability	10
		Improvement in data confidentiality	8
		Digital image storage	8
		Greater ease in accessing users' radiological data	18
	At the image quality level	Possibility of image post processing	10
		Optimization of image quality	17

Table 5 Disadvantages in the implementation of the new technologies.

Category	Subcategories	Subject	Number of mentions
Disadvantages	At the technical level	Increase in time required for the performance of examinations	14
		Loss of time with administrative processes	6
		Automation of tasks	12
		Increase in professional stress	8
		Decrease in team spirit	5
		System maintenance costs	3
		Frequent system crashes	11
		High technological investment	3
	At the level of services provided	Less direct contact with users	2
	At the efficiency level	Failures in interacting with other systems	2
		Lack of data confidentiality	6
		Difficulty in solving problems inherent to the system	25
	At the level of image quality	Decrease in image quality in certain imaging modalities	1

difficulty in solving problems inherent to the information system.

The success in the implementation of a new technology is something that does not have a single measurement, but several. One of the objectives was also learning the radiology technicians' opinion with regards to the benefits of the deployment of new technologies in the area of imaging sciences, for the institutions themselves. By analyzing Table 6, it is possible to observe that the benefits at the efficiency level were the most frequently mentioned, followed by the benefits at the level of care rendered to users. Thus, at the efficiency level, the accessibility to images throughout the in-

stitution and, the level of at the care rendered to users, an improvement in the quality of the services are highlighted.

DISCUSSION

When analyzing whether the number of years in service interfered in the adaptability to new technologies, it was possible to conclude that those technicians with longer time in service (31–40 years) are more satisfied with the use of the information systems, and also made more positive general evaluations of the technology they are using. Such results are not in agreement with those reported by Santos Júnior et al.⁽¹¹⁾,

that resistance of technicians with longer times in service is a potentially inhibiting factor in the adoption of new technologies in any type of organization.

All the technicians stated that the new technology is seen as a useful tool in their professional activities. Such results are in agreement with the study developed by Dias⁽¹²⁾, which confirmed the existence and interrelation of three motivational factors: usefulness, ease of use and pleasure. The technicians' previous knowledge on information technology contributed for their professional performance with the new system. Such results are compatible with those reported in the study developed by

Table 6 Benefits for the institution from the implementation of the new technologies.

Category	Subcategories	Subject	Number of mentions
Benefits	At the economic level	Decrease in material and human resources costs	15
	At the level of services provided	Improvement in quality of user service	13
		Improvement in quality of services	7
		Greater efficiency in user service	10
	At the efficiency level	Exchange of information with other institutions	11
		Better information management	9
		Image accessibility throughout the institution	28
Modernization of the operation		2	

Barreira et al.⁽¹³⁾, where 63.9% of the respondents considered that knowledge on information technology, previous competence and valorization of the professional activity contributed to the process of the information system implementation.

When investigating whether the use of the new technology was a factor of professional motivation, the authors observed that 57 technicians, or 98.3% of the sample, stated that the use of the new technology was a factor of professional motivation, exactly because a challenging job and the working conditions represent factors that influence the satisfaction/motivation of individuals⁽¹⁴⁾. With respect to the process organizational change with the implementation of information technology resources and the involvement of the staff members, most of the technicians responded favorably (58.6%), however, for a significant number (41.4%) this did not happen, as when technical and structural changes are associated with changes at the level of products/services, the organizations carry out adjustments in human resources management practices, with the purpose of increasing functional flexibility⁽¹⁵⁾.

Regarding the advantages of the implementation of the new technologies, the most frequently mentioned ones were related to the level of efficiency and technical level, because the deployment of a filmless radiology service is aimed at improving the accessibility and the integration of information by linking the images with the users' electronic records, and the application of new techniques for the development of new modalities of images acquisition, display, and processing⁽⁴⁾. With respect to the disadvantages of the implementation of the new technologies, they

were mostly at the efficiency level, because of the increase in the time required for the examinations and because the automation of tasks implied difficulties to solve problems inherent to the information system. These results are not in agreement with the study developed by Soares⁽⁶⁾ who reports that the implementation of a digital radiology system allows the examinations to be performed in less time, with a better time management, both by the technician who would then be able to perform more examinations, and the radiologist, that would receive the images more swiftly and would be able to prepare the report in a shorter time. On this subject, Laudon & Laudon⁽¹⁶⁾ report that the interrelation between technology and people is a relevant factor for the organizations that must to changes, and the people must know how to manage, understand and responsibly utilizing the technology in the benefit of the organization.

In what concerns the benefits to the institution resulting from the implementation of the new technologies, it is possible to say that they are mostly at the efficiency level (image accessibility) and at the level of the service rendering (improvement in the quality of the services), as the benefits are innumerable, including the possibility of making the images available at any location of the institution in a very short time, the data confidentiality, and also the possibility of exchanging information and experience with other institutions by means of teleradiology⁽⁶⁾.

CONCLUSIONS

It is widely known that information systems represent an indispensable source of

knowledge and a powerful support to the decision making process, allowing important gains for the health of all the users of health centers. In order for these gains to materialize, the workflow of health professionals must be optimized, i.e., data must be stored in dynamic information system solutions operating as a system for supporting medical decisions.

More than providing answers and conclusions, the present study in the area of new technologies in radiology proposes a reflection on the different factors involved in the process of information systems implementation in a hospital environment, contributing to promote a greater consciousness among organizations and researchers involved in the investigation of this matter.

Furthermore, this study allows the conclusion that such professionals are conscious of their relevant role in the health system, and therefore require the support of the investigation and application of the respective results, as an indispensable factor for the development of a professional activity that happens in the scientific, technical and human fields, in the sense of keeping up the appropriateness of new the technologies to new and growing demands of the information and knowledge society.

REFERENCES

1. Serrano A, Fialho C. Gestão do conhecimento – o novo paradigma das organizações. Lisboa: FCA – Editora de Informática; 2003.
2. Macedo HAS, Rodrigues VMCP. Programa de controle de qualidade: a visão do técnico de radiologia. Radiol Bras. 2009;42:37–41.
3. Fernandes A. O papel dos sistemas de informação na modernização do sistema de saúde. Diálogo. 2006;52:18–9.
4. Azevedo-Marques PM, Caritá EC, Benedicto AA, et al. Integração RIS/PACS no Hospital das Clí-

- nicas de Ribeirão Preto: uma solução baseada em "web". *Radiol Bras.* 2005;38:37-43.
5. Lima JJP. Técnicas de diagnóstico com raios X. Aspectos físicos e biofísicos. Coimbra: Imprensa da Universidade de Coimbra; 2005.
 6. Soares P. PACS. In: Gaivão FM. *Imagiologia clínica: princípios e técnicas*. Coimbra: Serviço de Imagiologia dos Hospitais da Universidade de Coimbra; 2005. p. 337-53.
 7. Ferreira M. Radiologia convencional/digital. In: Gaivão FM. *Imagiologia clínica: princípios e técnicas*. Coimbra: Serviço de Imagiologia dos Hospitais da Universidade de Coimbra; 2005. p. 355-69.
 8. American College of Radiology. *ACR technical standard for teleradiology*. Reston: American College of Radiology; 1996. p. 913-23.
 9. Agostinho A. Telerradiologia. In: Gaivão FM. *Imagiologia clínica: princípios e técnicas*. Coimbra: Serviço de Imagiologia dos Hospitais da Universidade de Coimbra; 2005. p. 327-35.
 10. Rodrigues V, Nogueira F, Granjo C. What implications do information systems have for the restructuring of health organisations? *Proceedings book of the IASK International Conference Global Management*; 2007;284-9.
 11. Santos Junior S, Freitas H, Luciano EM. Dificuldades para o uso da tecnologia da informação. *RAE-eletrônica*. 2005;4(2):art 20.
 12. Dias DS. Motivação e resistência ao uso da tecnologia da informação: um estudo entre gerentes. *RAC*. 2000;4:51-66.
 13. Barreira A, Santos E, Silva JC, et al. Estudo dos factores que interferiram no processo de informatização do serviço de Urgência do Hospital Distrital de Chaves. *Livro de Actas do I Encontro de Investigação: da divulgação à consolidação do conhecimento*. Vila Real: Escola Superior de Enfermagem de Vila Real; 2005. p. 43-50.
 14. Ferreira JMC, Neves JG, Caetano A. *Manual de psicossociologia das organizações*. Lisboa: McGraw-Hill; 2001.
 15. Caetano A, Tavares S. *Tendências na mudança organizacional e tensões na gestão de pessoas*. Lisboa: Dinâmia – Centro de Estudos sobre a Mudança Socioeconómica; 2000.
 16. Laudon KC, Laudon JP. *Sistemas de informação*. 4ª ed. Rio de Janeiro: LTC; 1999.