# 47 Shipping Telemetry Systems

Stavroula Chela, Dpt. of Automations, Piraeus University of Applied Science Piraeus, Greece, E-mail: vchela@gmail.com

Dr. Christos Drosos, Dpt. of Automations, Piraeus University of Applied Science Piraeus, Greece, E-mail: drososx@puas.gr

Dr. George Stamoulis, Professor , Dpt. Of Informatics, University of Thessaly, Lamia, Greece E-mail: georges@inf.uth.gr

Dr. Konstantinos Kalovrektis, Dpt. Of Informatics, University of Thessaly, Lamia, Greece E-mail: kkalovr@uth.gr

## 47.1 Abstract

The aim of the Thesis to investigate the Shipping Telemetry Systems (SCADA type) with the help of information systems evaluation models (TAM, IS Success) to draw useful conclusions on the satisfaction of their users and the success of the systems. The research methodology follows the Mixed Method Research (MMR), uses a combination with the quantitative method by using questionnaires and qualitative method by using interviews. The sample numbers 47 users (quantitative research) and 3 manufacturers (qualitative research). The research findings found that: It seems marine telemetry systems are successful in their application area according to the users and the companies-manufacturers and тhe overall evaluation of the systems is high from the stakeholders.

## 47.2 Key-Words

Shipping Telemetry Systems, SCADA, TAM, IS success, evaluation, satisfaction

## 47.3 Introduction

The sipping telemetry system (STS) is an SCADA system in maritime sector. This paper has proposed and used a framework (research model) STS evaluation. It is a combination two models: TAM & IS SUCCESS. It examines various shipping telemetry system in the light of an integrated evaluation framework that includes the user satisfaction and acceptance of technology. The findings provided to fill the conceptual gap between user satisfaction and technology acceptance of information system for STS.

## 47.4 Background

The supervisory control and data acquisition system (SCADA) application is a branch of Industrial Information and referred to the combination of telemetry and data acquisition (Figure 1). SCADA systems, uses the programmable logic controllers (PLC) for monitoring all those critical parameters of an industrial process (e.g. pressure, temperature, humidity, etc.) Required for supervisory control, real-time [1], [2], [5], [6], [7], [8], [9].

Telemetry associated with SCADA systems is the transmission technique and data reception with an agent means. These data are measured and transferred wired or wirelessly, usually from multiple points. The yield of a separate address to every point (addressing) is part of the SCADA system. Data acquisition is an access method, handling and data collection and collaborating with the SCADA telemetry system for transferring the data [2], [3], [9].

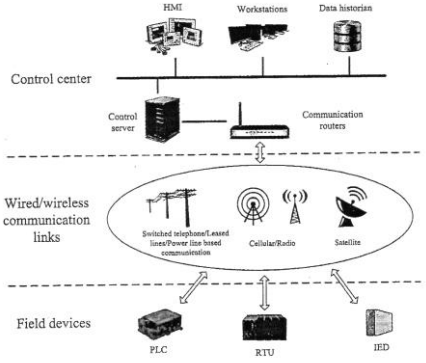


*Figure 1.SCADA System*

In particular, the shipping use SCADA systems to collect measurements and visual inspection started the implementation in propulsion engines (Figure 2). The target is the reduction of human resources and to improve the safety of personnel and equipment. Today, with the development of new technologies (IT, robotics, mechatronics, internet), telemetry and supervisory intelligence and control systems are expanding continuously, increasing the level of integration of existing ship systems [10].

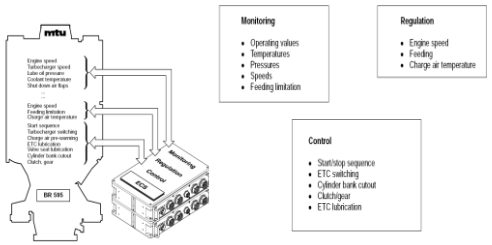


*Figure 2. The propulsion engine control with ECS-UNI 595/M system (pressure, temperature, fuel supply)*

Below are images of the most important SCADA systems used in the shipping and transport industry, especially in the Greek market:

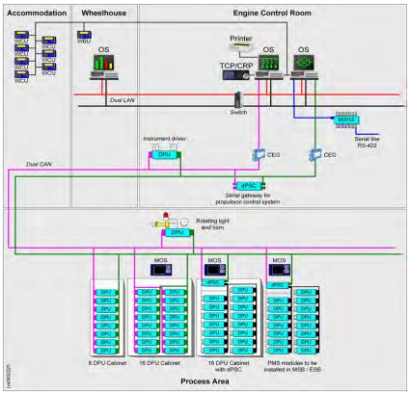


*Figure 3. K-Chief 500 system topology*

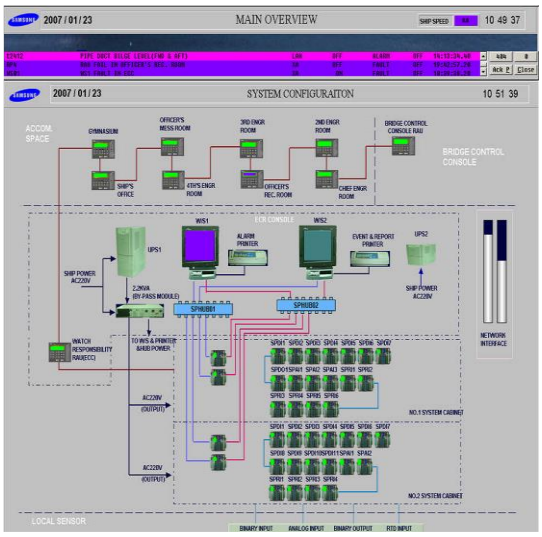


*Figure 4. SSAS-Pro system topology*

## 47.5 Methodology

### 47.5.1 Research model

This Research follows the mixed methodology (Mixed Methods Research) which comprises the following parts:

(a) Qualitative research
- Interviews with experts from companies supplying shipping telemetry systems
- Pilot study

(b) Quantitative research
- Questionnaires shipping telemetry system users
- Pilot survey
- Main survey

The structure of the research model of this study (a combination of IS evaluation models: TAM & IS success)[11],[12],[13],[14] is shown in the following figure:

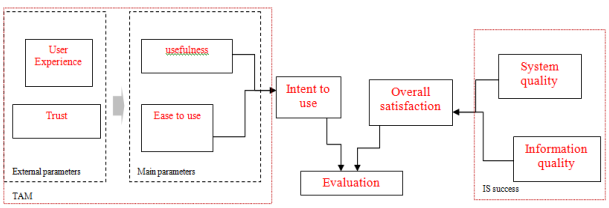


*Figure 5. Research model*

### 47.5.2 Research Objectives

The Research Objectives are:

- *RO1:* To investigate the acceptance of technology shipping telemetry systems by their users.
- *RO2:* To investigate the satisfaction of shipping telemetry system users.
- *RO3*: To investigate the overall assessment of shipping telemetry systems.

## 47.5.3 Hypothesis

The Hypothesis (Quantitative research) of Research Model (Fig.6):

*H1.0* The intended use of shipping telemetry systems is not affected by the usefulness
*H1.1* The intended use of shipping telemetry systems is affected by the usefulness

*H2.0* The intended use of shipping telemetry systems is not affected by the perceived Ease of Use
*H2.1* The intended use of shipping telemetry systems is affected by the perceived Ease of Use

*H3.0* The intended use of shipping telemetry systems is not affected by the Experience
*H3.1* The intended use of shipping telemetry systems is affected by the Experience

*H4.0* The intended use of shipping telemetry systems is not affected by the Trust
*H4.1* The intended use of shipping telemetry systems is affected by the Trust

*H5.0* The system quality is not affected by the information quality
*H5.1* The system quality is affected by the information quality

*H6.0* Overall satisfaction of the shipping telemetry system is not influenced by the intended use
*H6.1* Overall satisfaction of the shipping telemetry system is not influenced by the intended use

*H7.0* Overall satisfaction of the shipping telemetry system is not influenced by the system quality
*H7.1* Overall satisfaction of the shipping telemetry system is not influenced by the system quality

*H8.0* Overall satisfaction of the shipping telemetry system is not influenced by the information quality
*H8.1* Overall satisfaction of the shipping telemetry system is not influenced by the information quality

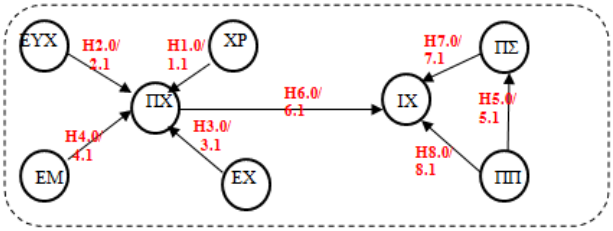


*Figure 6. Hypothesis framework*

### 47.5.4 Research Questions

The Research questions (Qualitative research) of Research Model (Fig.7):

- *Q1*: What is the effect of TAM model factors regarding the acceptability of shipping telemetry systems by companies-manufacturers point of view?
- *Q2*: What is the effect of the IS model success factors regarding the degree of success of shipping telemetry systems by companies-manufacturers point of view?
- *Q3*: What is your overall assessment of shipping telemetry systems by companies-manufacturers point of view?

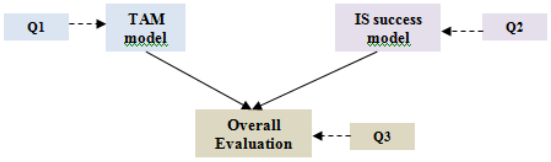


*Figure 7. Research Question framework*

### 47.5.5 Triangulation

The Research questions (Qualitative research) of Research Model:
The triangulation is a combination of data sources (users, companies-manufacturers) and linking research hypotheses - research questions (Fig,8):

*RO1:*Set $H_1$: {H1.0/1.1,H2.0/2.1, H3.0/3.1, H4.0/4.1} *AND* EE 1.1
*Ro22:*Set $H_2$: {H5.0/5.1} *AND* EE 2.1
*RO3:*Set $H_3$: {H6.0/6.1, H7.0/7.1, H8.0/8.1} *AND* EE 3.1

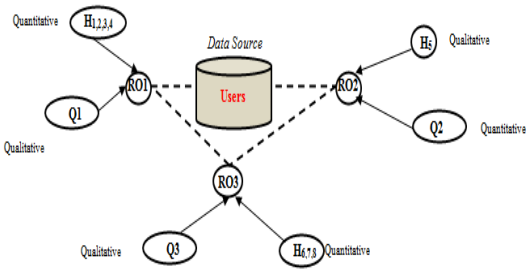


*Figure 8. Triangulation procedure*

### 47.5.6 Sample

The sample of this research consisted of 47 users (Quantitative research) and 3 companies-manufacturers (Qualitative research).

### 47.5.7 Tools

This research contains:
(a) Quantitative research: we use a questionnaire (31 questions and comments).
(b) Qualitative research: we use a hemi-structure interview (21 questions and comments).

### 47.5.8 Data Analysis

The quantitative analysis of this research includes the following techniques:

- Pilot study
- Analysis of reliability - validity
- Demographic sample analysis (using techniques of descriptive statistics)
- Hypothesis testing (regularity audit, using statistical parametric test or not)
- Export findings

Qualitative analysis of this research includes the following techniques:

- Pilot study
- Analysis of reliability - validity
- Codification participants
- Interpretation-text analysis (using encoding technique)
- Outcome of conclusions

The triangulation of this research includes:

- Findings of research (qualitative & quantitative) connections

## 47.6 Results

### 47.6.1 Reliability and Validation

This research has the following quality reliability and validation criteria due to small sample:

(a) Reliability
- Professional experience of researcher (>10 years)
- confirmatory reliability
- triangulation

(b) Validation
- Face validation (pilot research)
- Models validation (TAM & IS success)
- Transferability (inductive approach: RO to Hypothesis/research question)
- Dependability (organized research design)

### 47.6.2 Quantitative Analysis

The profile of the sample users telemetry systems is:

Table 1. Users Profile

| Types of Shipping Telemetry System | Users of sample (N) |
|---|---|
| Kongsberg K-Chief 500 | 24 |
| Kongsberg K-Chief 2000 | 4 |
| Siemens Win CC | 21 |
| Samsung SSAS-Pro | 12 |
| Hansin | 4 |
| ABB | 4 |

The evaluation of shipping telemetry systems users gather high scores (> 6) with the highest Hansin system and lower the Kongsberg K-Chief 2000 system.

The results of Hypothesis analysis are (Tab.2):

- using *Kolmogorov-Smirnov (K-S) & Shapiro-Wilk (S-W)* Test (research variables): have no normal distribution (Sig <0,05), and
- using non-parametric tests (Kruskall-Wallis, Mann-Whitney)

*Table 2. Hypothesis Results*

| Hypothesis | Findings |
|---|---|
| H1.0/1.1<br>H2.0/2.1<br>H3.0/3.1<br>H4.0/4.1 | Sufficient effect the utility to use intention<br>Moderate effect on ease of use intended use<br>Moderate impact the user experience intended use<br>High impact confidence in the intention to use |
| H5.0/5.1 | The information quality affects the mediocre quality system |
| H6.0/6.1<br>H7.0/7.1<br>H8.0/8.1 | Moderate effect of using prosthesis in overall satisfaction<br>High impact of quality systems in overall satisfaction<br>Moderate effect of quality information to overall satisfaction |

## 47.6.3 Qualitative Analysis

The qualitative analysis followed the coding methodology (open coding):

*Table 3. Coding Results*

| Ερωτήματα | Αποτελέσματα |
|---|---|
| Q1 | High degree of impact the usefulness, ease of use, trust |
| Q2 | High quality information and systems |
| Q3 | High overall satisfaction (High satisfaction individual users of products and companies) |

## 47.6.4 Triangulation Process

The following table shows the correlation quantitative and qualitative research findings by research objective:

*Table 4. Triangulation Results*

| Research Objectives | Correlations |
|---|---|
| *Research Objective 1* **Acceptance** | Trust & utility systems due to the reliability, security and good training of operators |
| *Research Objective 2* **Success** | Technical specifications provide fast, accurate and reliable information |
| *Research Objective 3* **Overall satisfaction** | High overall evaluation (and sub-systems) agree users and companies |

## 47.7 Conclusion

The research finding showed that:

- All factors of TAM model affect the *intended use*. The biggest impact has the *confidence* (external factor), followed by the *utility*.
- The IS Success factors have little effect according to users, but according to companies-manufacturers there is high quality of systems and information.
- The overall evaluation of the systems is high for users and companies-manufacturers.

The future relative research would be useful for the concerned developers-companies to design better shipping telemetry systems.

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