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Stakeholder management for public private partnerships

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Abstract

Various problems have been encountered on public private partnership (PPP) initiatives around the world that have eventually led to project failure. Stakeholder opposition has been reported as the main reason for failure in several instances. As such, capturing and addressing of stakeholder inputs is crucial to the success of PPP projects. Stakeholder involvement (SI) is an interdisciplinary domain that spans many disciplines (engineering, sociology, psychology, marketing, etc). The fragmented nature of knowledge in this domain is impeding project managers from leading successful SI programmes. As such, this paper presents a semantic model and taxonomy that represents the key concepts underlying stakeholder involvement in PPP infrastructure projects. The model has the potential to act as a core for knowledge representation, sharing and reuse in the multidisciplinary domain of SI. A portion of the model is implemented in a knowledge-base that can be used to recommend the most suitable set of stakeholder involvement tools to be utilized on a particular project. The recommendations provided by the system can act as a 'short-list' of potential tools to the inexperienced SI coordinator.

Keywords: Public private partnerships; Stakeholders; Project management; Information technology; Implementing strategy

1. Introduction

Public private partnerships (PPP) is not a totally new concept in infrastructure development. In fact, the first PPP in modern history was the concession formed in 1854 to construct and operate the Suez Canal [10]. On the other hand, the concept of involving project stakeholders in the decision-making process has come a long way since then. In retrospect, public pressure for or against any decision related to the Canal was non-existent in the 19th century. Two centuries later, public concerns are a much more decisive factor for PPPs. In fact, the World Bank points out seven major factors that are holding up private investment in infrastructure, the first factor being, "A wider gap between the expectations of the governments and the private sector on what is reasonable and acceptable" [2].

PPP infrastructure projects vary in the level of contention that they raise among stakeholders. Service infrastructure like hospitals and schools where the private entity provides non-technical services to the facility (everything except medical care and teaching), are much less likely to raise opposition among the public if compared to other basic infrastructure like highways or water supply. Moreover, the involvement of the private sector – with its profit-making mindset – usually raises concerns that are not usually likely when the asset is publicly owned (e.g. rate hikes, quality assurance, safety, and transfer agreement).

In general, stakeholders are individuals or organisations that are either affected by or affect the development of the project. Therefore, capturing their input is a crucial component of the project development process. It is important to gauge stakeholder opinion and concerns to better facilitate the development of a project that will meet the needs of

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those stakeholders. A SI programme is one which determines stakeholder concerns and integrates them into the design of a project to achieve collaborative integrated project development. Understanding of the concepts that underlie SI to infrastructure projects is an essential step towards creating a strong involvement to help project proponents and stakeholders communicate effectively. This paper presents a semantic model and taxonomy for SI in infrastructure projects.

2. Importance and relevance of stakeholder involvement in PPP projects

Various problems have been encountered on PPP initiatives around the world that have eventually led to project failure. Public opposition due to various factors has been reported as the main reason for failure in several instances. Major PPP transportation initiatives in the United States have reportedly failed due to stakeholder opposition. These failures were mainly because the public was (a) unaware of the concept of P3, (b) not sufficiently educated about P3 and, (c) denied access to detailed information contained in the consortium's P3 proposals [10]. An important example is Malaysia's unsuccessful initiative to privatise its sewer system. In a 'shady' hand-over, the transfer of the system to the private entity took place without knowledge of the public. The lack of transparency in the award stoked allegations of 'cronyism' among the public in Malaysia. Continued public opposition towards the award process and the financing structure (which was seen as entirely in the favor of the consortium) eventually drove the government to re-purchase the sewer system [1]. Furthermore, SI in hazardous waste disposal projects can be a key factor in their success. Due to the sensitive nature of hazardous waste disposal projects, public opposition has been a main imperative in holding back the construction of new sites. Since 1980, waste sites in the United States have only had a 3% chance of success due to public opposition [9].

3. Stakeholder involvement in infrastructure projects

Stakeholder involvement (SI) in infrastructure projects plays a very important role. 'Stakeholder involvement' has now replaced the more limited term of 'Public involvement' in the context of infrastructure development. Accordingly, a stakeholder refers to any person or organisation that has a legitimate interest in a project. To capture stakeholder input, a thorough stakeholder involvement programme has become an integral part of infrastructure projects. The programme can be administered by the project owner, designer or contractor depending on project specific requirements. SI programmes have been successfully implemented in Transportation, Water Resources, Water Supply, Mining, and Land Development projects. Fig. 1 shows instances where SI programmes were used in infrastructure development projects along with a brief description of the SI programme. The diagram indicates major concerns expressed by stakeholders, and the tools that were utilised to involve stakeholders [3,5–10,12–17,19].

4. Stakeholder involvement in planning and designing

To ensure a true SI programme in these phases, the public has to be taken in full confidence that their involvement will influence the decision making process [18]. Transparency and trust in the SI process is vital to its success. Stakeholders tend to be skeptical about the involvement programme, if they believe that decisions have been made before-hand. This will have a negative effect on the level of participation in the programme; individuals may either tend to participate in an antagonistic way or to refrain from participation altogether.

The public's concerns in these phases will usually focus on long-term issues and can be of any kind depending on local conditions. Two SI programmes on a bridge project in the United States showed very contrasting public concerns. For instance, the public may be interested in preserving the historic value of a bridge and thus will show more emphasis on aesthetics than on new technology [15]. In another case, the main public concern on a bridge construction project was the project's effect on businesses, influence on job market and, usage of local labor and material, rather than the environmental or aesthetic impacts of the project [11]. These differences were mainly due to the socio-economic conditions of the surrounding communities.

5. Stakeholder involvement in the construction phase

During this phase of infrastructure project development all stakeholders are involved, but the way of involvement is different. Local and regional stakeholders are concerned with the influence of construction activities on their daily routine activities and life style [6]. On the other hand, global stakeholders may be interested in monitoring and evaluating project impacts related to their particular field to make sure that the impact is not greater than what was considered in the planning phase.

Although the SI process in general is similar in planning and construction phases, some differences do exist between the two. The most fundamental difference is the purpose of the process itself. The main aim of involving the public in the planning and design phases of the project is to inform stakeholders and obtain their feedback regarding the most suitable design for a project. The process is usually a 2-way process. On the other hand, in the construction phase, the public involvement process is usually a 1-way process. It usually focuses on the dissemination of construction-related information to the public (road closures, construction sequence, etc.) and creating problem solving channels in case construction activities affect the local community in any way.

Domain			Major Concern	Description of Public Involvement	Main Public Communication tools	Reference
Transportation	Highway Construction		Inconvenience During Construction	Expectation from facility, and selection between alternatives	Meetings, Workshops, Door-to-door visits, Site Office	[6]
	Bridges	Aesthetics	Represents Community		Meetings, Surveys, Workshops, Computer aided graphics, Mock-ups	[15]
		Structure Type	Performance, Cost Use of Local Labour and Material		Meetings, Workshops, Surveys	[10]
	Transit Planning		Flexibility, Speed, Reliability, Cost		Notifications, Meetings, Workshops, Surveys	[7]
	Transportation Planning		Land use, Air quality, Accessibility, Mobility, Economic growth		Open House, Workshops, Information Kiosks, News letters, Website	[8], [17]
Water	Water Resource		Number of people benefited, extent of benefit, Quality, Cost	Selection between alternatives	Interviews, Notifications, Meetings, Workshops, Surveys	[16]
	Water Supply		Effect on land (esp. privately owned), People and area's ecological system		Meetings with community and its leaders, local meetings with Landowners, Public workshops, Media outreach	[14]
	Water Treatment		Quality and price of water, reliability on supply, disruption in view due to treatment plant	Can influence in the location of treatment plant, detailing their requirements	Meetings, Workshop, Door-to-door visits	[13], [19]
Mining			Jobs opportunities, Reclamation of land, threat to near-by communities, and wild life	Choosing company that can get access to site, Satisfaction that area will be restored to maximum possible level	Interviews, Meetings-discussions and showing Pictures (before, during, after the project) of previous mining sites on which that company involved.	[3], [5]
Solid Waste Management			Effect on neighborhood air quality	Site Location (especially the location of incinerator)	Meetings with local organizations, Notifications, Press releases	[12]
Hazardous Waste Disposal			Effect on environment overall, distrust in facility operator, devalued real estate	Site Location, Facility profit reinvested in community	Public hearings	[9]

Fig. 1. Summary of research relating to stakeholder involvement in infrastructure development.

6. Semantic model and taxonomy

A semantic model was developed to capture and incorporate stakeholder input in the design. The model consists of five main entities: processes, products, constraints, actors and resources. Each of these is presented in the following sub-sections. Some entities were acting as clustering concepts under which knowledge concepts can be categorized. For example, a process has an implementation phase which could be in the pre-design phase of the project development, during-design or post-design. It has a style which could be Web-based or non-Web-based; and has time-span which could be short-term or long-term. The concepts defined in the model were implemented using the Protégé ontology editor in a taxonomy (a collection of terms, used to refer to certain concepts, which are arranged in a class hierarchy). The model and the taxonomy were validated through a series of interviews with three industry experts. All three experts were engaged in stakeholder participation and consultation for infrastructure development projects, one of the experts being a public consultation specialist.

7. Processes

In order to obtain stakeholder input for effective collaborative infrastructure development, various processes shall be executed, including proper management and planning at every stage of the overall SI process. Fig. 2 shows a partial view of a process-centered UML class diagram that defines the main processes included in a SI process. The following is a brief overview of the main processes.

7.1. Stakeholder involvement programme design

This includes stakeholder involvement strategy development, stakeholder involvement planning and stakeholder

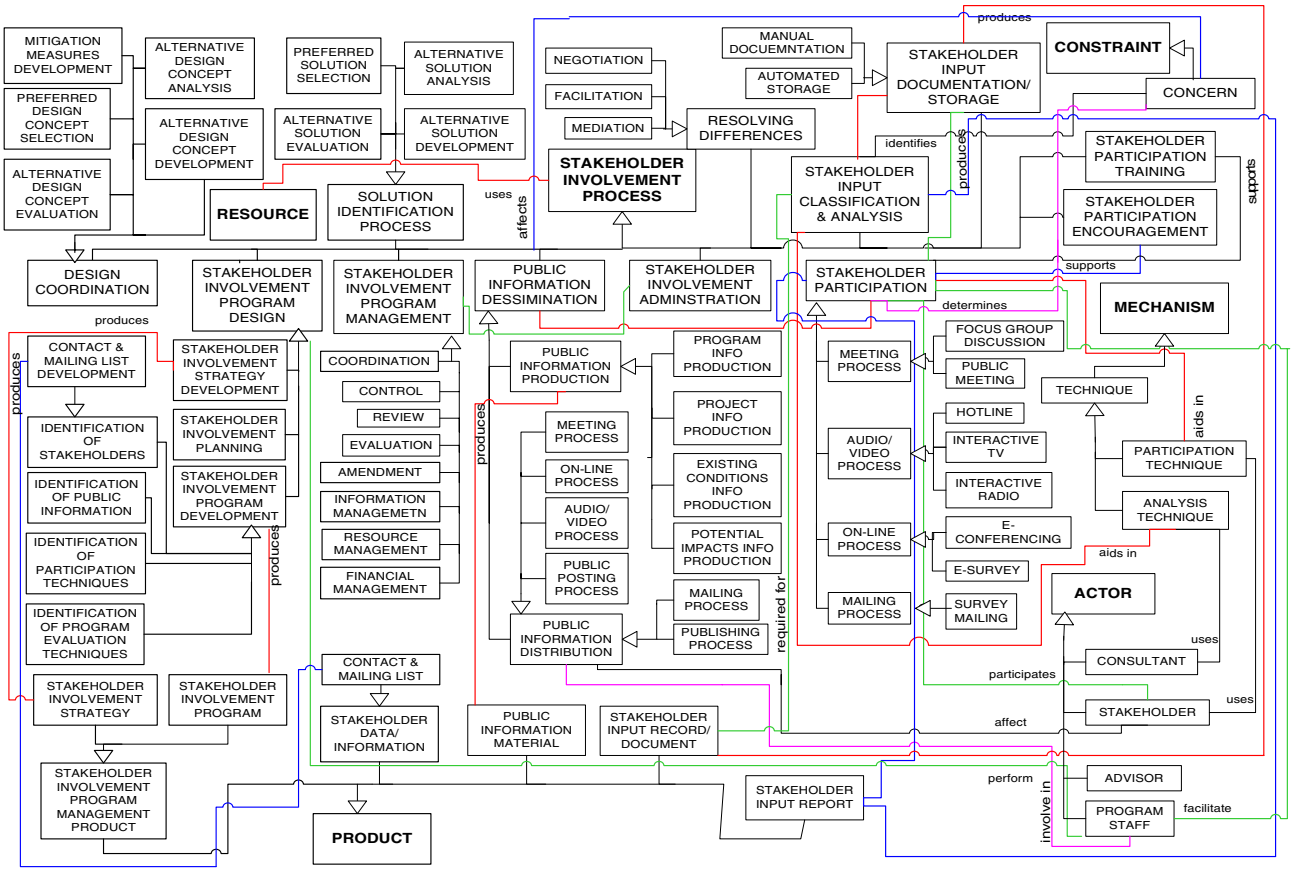

Fig. 2. Stakeholder involvement processes.

involvement programme development processes. Stakeholder involvement strategy development defines the initial approach to the programme by determining its overall strategy. The process is mainly defining the major objectives, requirements and methods of getting stakeholders involved. Research and lessons learned from previous projects could be a valuable input here. Stakeholder involvement planning is the second step in programme design. For successful infrastructure development, the stakeholder involvement process is one of the core requirements and hence effective planning is needed for each step enclosed in the process. Research and lessons learned from previous projects could also be a valuable input here.

After planning the entire programme, the stakeholder involvement programme is formalised; this relates to the stakeholder involvement programme development. It includes decisions on major issues, such as identification and profiling of stakeholders that shall be involved, defining information that shall be disseminated to them, defining input required from them, defining stakeholder roles, and identifying suitable techniques throughout the programme execution. This incorporates public information dissemination techniques, participation techniques, and input classification and analysis techniques; as well as techniques for training and encouraging stakeholders to participate. A programme also defines suitable evaluating techniques and performance measures to address the need for necessary amendments to the programme.

7.2. Stakeholder involvement programme management

This is a major process which is followed at every level of the stakeholder involvement processes. The management could be for resources, information, finance, etc. It is the act of directing and controlling all processes of the system. For example, the cost estimation, budgeting and the cost control form the components of the financial management process. Programme management also includes processes such as stakeholder involvement programme coordination, stakeholder involvement programme documentation, stakeholder involvement programme control, stakeholder involvement programme review, stakeholder involvement programme evaluation and stakeholder involvement programme amendment. In stakeholder involvement programme control and review processes, the programme at each level is kept under a control system. This system has the capability of monitoring the programme and keeping track of all processes. The information collected is forwarded to the programme evaluation and amendment processes. The stakeholder involvement programme evaluation and amendment processes are meant for evaluating the performance and success of the programme in

meeting its objectives and, if needed, suggest any amendment that may be required. These processes initiate from the start of the project and hence each process that is monitored can be amended suitably when required.

7.3. Stakeholder involvement administration

This incorporates processes such as maintaining documents, record keeping, obtaining necessary approvals and logistics management.

7.4. Public information dissemination

Dissemination is the process of communicating information to the subject stakeholders. This involves public information production and distribution of public information to stakeholders. Distribution of public information could be performed through mailing, publishing, public posting, audio and video interaction, on-line, or meeting processes.

7.5. Stakeholder participation

This encompasses meeting processes such as individual meetings, personal surveys, focus group discussions, workshops, public meetings, public hearings, open-houses, conferences, and seminars; audio and video interaction processes such as telephone surveys, hotlines, telephone interviews, teleconferencing and electronic town meetings; on-line processes such as electronic bulletin boards, electronic surveying, and electronic conferencing; and mailing processes such as mail surveying.

7.6. Stakeholder participation training

This process covers the training of programme staff, as well as stakeholders. Programme staff may require training on how to conduct the stakeholder involvement programme, including running of meetings, usage of participation and analysis techniques, etc. Also, depending on the type of stakeholders, stakeholders may require training on how to participate. This training might cover guidelines, instructions, and training on using on-line techniques, etc.

7.7. Stakeholder participation encouragement

This process plays an important role since without stakeholder participation, the objective cannot be met. Hence, establishment of the involvement programme with more stakeholders, by encouraging them, could yield more representative results. Stakeholders could be encouraged through site-visits, seminars, contests and acknowledgments.

7.8. Resolving differences

This process deals with resolving a difference before and after it reaches the stage of a dispute. It includes facilitation, negotiation, mediation and arbitration.

7.9. Stakeholder input documentation and storage

This process is modeled separately from the administration, as it involves major processes of input recording. This could be in the form of manual documentation such as record keeping or automated electronic storage of input such as computerised tracking.

7.10. Stakeholder input classification and analysis

Input obtained from stakeholders requires proper classification and analysis. This includes screening of input, classifying input according to pre-defined criteria, summarising, and analysis. For example, the input can be broadly classified as involvement programme concerns, system performance concerns, environmental concerns, safety concerns, political concerns, social concerns, economic concerns and travel concerns, when dealing with street development. On the other hand, input summarisation includes identification of needs, concerns, problems and opportunities.

7.11. Solution identification

The solution identification process is a cornerstone in the involvement programme as it is the first step in incorporating the stakeholder input in the decision-making process. It includes development of alternative solutions based on stakeholder input, analysis of these different solutions with respect to technical design criteria and stakeholder opinion, evaluation of the solutions, and finally selection of preferred solution (s) and development of preliminary mitigating measures.

7.12. Design coordination

Design coordination is required once a preferred solution (s) is selected. This includes alternative design concepts development, alternative design concepts analysis, alternative design concepts evaluation, preferred design concept selection, and mitigating measures development.

8. Products

Products refer to the elements, physical or managerial, that are either an input or output of a process. Products include programme management products, such as stakeholder involvement strategy. Another main programme management product is the stakeholder involvement programme itself, which is produced from the stakeholder involvement programme design process. Products also include products of information and data about stakeholders identifying the various attributes of the stakeholders, such as education level, language, religion, ethnicity, cultural background, level of interest, contact and mailing address, etc. A contact and mailing list is an example of such products. In addition, public information material is

used to communicate necessary information about the programme and project development to stakeholders. On the other hand, stakeholder input records and documents are products encompassing the input of stakeholders, while a stakeholder input report involves the presentation of all concerns from all defined stakeholder groups and consultants after their classification and analysis. Finally, products also include information on alternative solutions and design concepts. Fig. 3 shows a partial view of a UML class diagram that depicts the main products of the model. As such, products are composed of seven sub-products as follows.

8.1. Stakeholder involvement programme management product

These are products related to the management of the programme itself, such as stakeholder involvement strategy, plan, programme, and evaluation report.

8.2. Stakeholder data and information

These are data and information about the stakeholders such as their profiling report, and contact and mailing list.

8.3. Public information material

These include stakeholder involvement programme information, project information, study area information, existing conditions information, and potential impact information. All information were further classified as electronic material such as Web bulletins, paper and hard material such as fact sheets, video and audio material such as radio announcements, and presentation material such as projector slides.

8.4. Stakeholder input records and documents

These are paper and hard documents, computerized records, or physical items.

8.5. Stakeholder input report

This is a report for each of the major concern categories, such as environmental concerns report.

8.6. Alternative solutions information

These include description of needs, description of concerns, description of problems, description of opportunities, description of alternatives, description of evaluation criteria, description of results, description of alternatives assessment, description of selected alternatives and description of mitigating measures.

8.7. Design concepts information

Similar to alternative solutions information, information related to design concepts include description of needs, concerns, problems, etc.

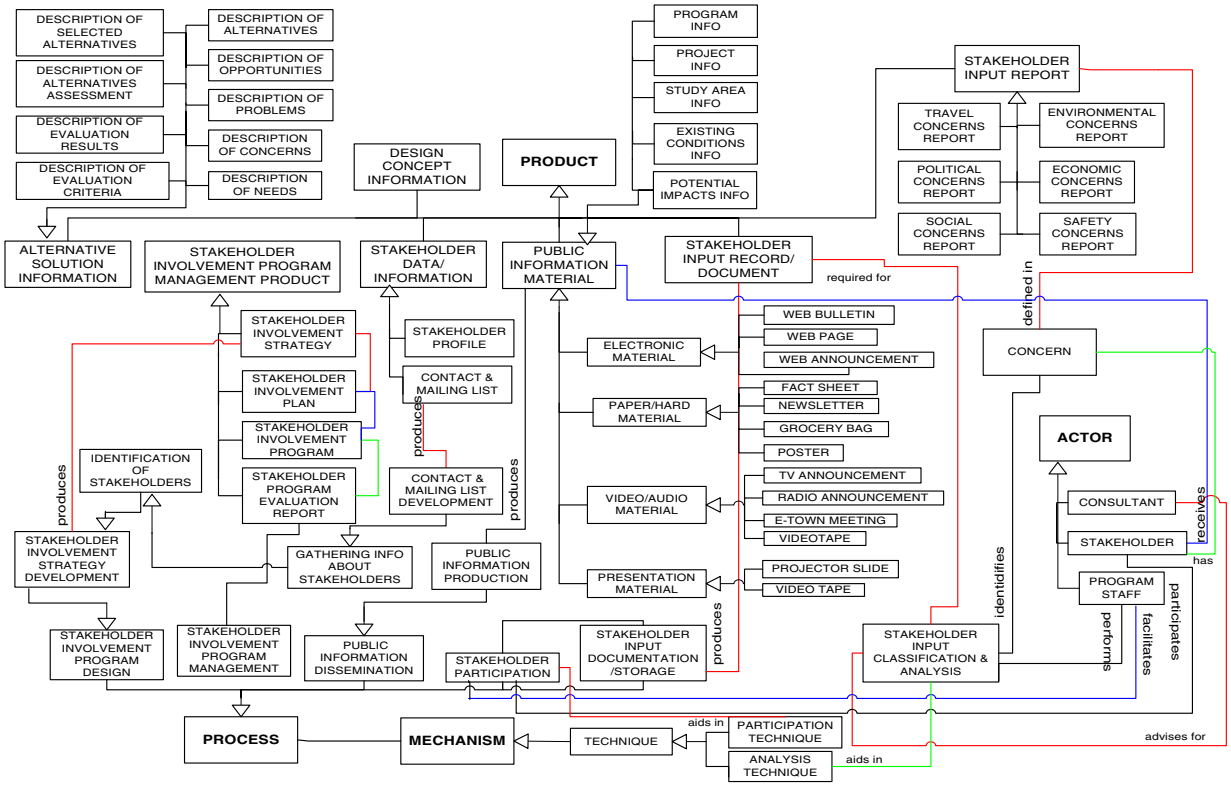

Fig. 3. Stakeholder involvement products.

9. Actors

The actors are those who have active involvement in the planning and implementation of the programme. Actors were modeled as stakeholders, consultants, advisors, or program staff.

9.1. Stakeholders

Stakeholders are modeled as responsible, impacted or interested. *Responsible stakeholder* refers to an organisation or individual who has some degree of responsibility or liability with regard to the development project, such as health officials, developers and Business Improvement Associations (BIAs). An *impacted stakeholder* is an organisation or individual who is directly or indirectly affected by the development process; and was classified into three main sub-domains: *residents*, *users* and *owners*. Impacted stakeholders are further grouped as negatively or positively impacted. Finally, an *interested stakeholder* is an organisation or individual that is not directly impacted by the project, but who would like to participate and provide his opinion in the infrastructure development process. This includes various actors such as social institutions, environmentalists and media representatives.

9.2. Consultants

A *consultant* is an organisation or individual brought into the project to provide professional consultation in a particular field of interest. The consultant may provide programme administrators with certain guidelines that have to be followed for implementing the infrastructure development project and/or conducting the involvement process. Engineers, economists, sociologists, researchers, environmentalists, etc., and their organisations, could act as, consultants to the programme.

9.3. Advisors

An *advisor* is an organisation or individual who provides expert advice on some aspect of the project development. Advisors include politicians, business leaders, elected officials, etc.

9.4. Program staff

Program staff include programme manager, programme coordinator, public relations staff, facilitator, document controller, etc.

10. Constraints and concerns

Constraints affecting the stakeholder involvement process include *budget*, *schedule*, *code*, and *regulations*. On the other hand, *stakeholder concerns* are considered as constraints to the design process. Concerns refer to the general input of the stakeholders with respect to the infrastructure project being developed, including comments, needs, requirements or objections. Concerns were modeled into eight sub-domains:

10.1. Involvement programme concerns

Involvement programme concerns are related to the involvement scope, involvement process, involvement schedule, and evaluation criteria of alternatives and designs.

10.2. System performance concerns

System performance concerns are related to the desired performance characteristics and attributes of infrastructure systems such as comfort, person-carrying capacity, etc.

10.3. Environmental concerns

Environmental concerns deal with noise, vibration, air pollution, climate change, water pollution, soil quality change, landscape, wildlife, fish habitat, vegetation, visual intrusion, etc.

10.4. Safety concerns

Safety concerns address both construction area safety and operation safety, including safety of drivers, pedestrians, motorists, cyclists, etc.

10.5. Social concerns

Social concerns address various issues related to the welfare of the society including the quality of life, effects on public health, accessibility of public to various facilities, impacts on demographics and housing, effects on vulnerable groups, preservation of cultural heritage, national pride, community cohesion, promotion of active transportation, etc.

10.6. Economic concerns

Economic concerns include various critical issues, such as impact on land value, impact on businesses, impact on international trade, impact on tourism, impact on employment, impact on taxation, project financing, rate hikes, and contractual agreements.

10.7. Political concerns

Political concerns are the effects of the project development on politics, including re-elections, taxation policies, support of official plan, etc.

10.8. Travel concerns

Travel concerns mainly refer to issues such as accessibility, traffic flow, traffic time and inter-region connectivity. It

includes cycling concerns, parking concerns, public transit concerns, traffic concerns, and urban design and streetscaping concerns.

Stakeholder concerns have a certain degree of volatility associated with them. Concerns can be broadly classified as static or dynamic concerns. The extent to which a concern is spread throughout the community is an important aspect that needs to be modeled; thus, concerns can be viewed as either macro or local concerns. Concerns have a time framework associated with them. In this regard, concerns can be classified as either long-term or short-term concerns.

Some of the above-mentioned concerns are particularly sensitive for PPP projects, such as rate hikes and transfer agreement. Major concerns related to PPP projects also include project financing, effect on economic stability, operational safety, and temporary/permanent ownership of the constructed projects.

11. Resources

These refer to the resources required in order to conduct the programme. They are mainly software, hardware and finance. Resources also include previous knowledge such as studies, research and lessons learned.

12. Mechanisms

Mechanisms refer to the tools that aid in performing processes. The main mechanisms in this model are information dissemination techniques, participation techniques and stakeholder input analysis techniques.

13. Relationships and axioms

The ontology has various relationships to relate the different concepts of the ontology. Some of the relationships are:

- The relationship ''is_part_of'' assigns a process to a project.
- The relationship ''produce'' assigns a process to a product as its output.
- The relationships ''identify'', ''determine'' and ''affect'' assign a process to a concern.
- The relationship ''required_for'' assigns a product to a process as its requirement.
- The relationships ''participate'', ''advise_for'', ''facilitate'', ''involved_in'', ''perform'' and ''affect'' assign an actor to a process.
- The relationships ''used_by'' and ''aid_in'' assign a resource to a process.
- The relationship ''receive'' assigns an actor to a product.
- The relationship ''have'' assigns an actor to a concern.
- The relationships ''use'' and ''manage'' assign an actor to a resource.
- The relationship ''utilize'' assigns a process to a resource.
- The relationship ''defined_in'' assigns a concern to a product.
- The relationship ''support'' assigns a process to another process.

The ontology also includes a set of axioms that represents the limitations and constraints on the behavior of concepts. Axioms of the ontology are presented in natural language and First Order Logic. Examples of these axioms are:

- A stakeholder involvement programme may be under development, under review, under revision, or approved:
  $(\forall x)$ stakeholder_involvement_programme(x)$\supset$ (under_ development(x) v under_ review(x) v under_revision(x) v approved(x))
- An approved stakeholder involvement programme requires that the stakeholder involvement programme is certified by the authorised actor:
  $(\forall x,y)$ (stakeholder_involvement_programme(x)^actor (y)^ authorized_to_certify(y,x) ^ certify(y,x))$\supset$ approved (x)
- A public information dissemination process has to conform to an approved stakeholder involvement programme:
  $(\forall x,y)$ (stakeholder_involvement_ programme(x)^ approved(x)^public_dissemination_process(y))$\supset$has_to_ conform_to(y,x)
- A stakeholder participation process has to conform to the an approved stakeholder involvement programme:
  $(\forall x,y)$ (stakeholder_involvement_programme(x)^ approved(x)^ stakeholder_participation_process(y))$\supset$ has_to_conform_to(y,x)

14. Model implementation

A portion of the SI model was used to create a prototype knowledge base. The purpose of the knowledge base is to recommend to the SI programme developer a set of appropriate SI tools to use based on selected criteria. The SI model helps in analysing the factors that influence the choice of the SI tool. The prototype focuses on six main factors, namely the type of information that needs to be communicated, project phase, SI programme budget, involvement purpose, stakeholder level of interest and the amount of information that needs to be communicated. A set of rules were created based on a careful analysis of successful SI programmes (Fig. 1) and discussions with expert SI programme coordinators.

Each of the six influencing factors were considered separately in the analysis and SI tools were rated on a five scale suitability scale of *Very Suitable*, *Suitable*, *Neutral*, *Somewhat Unsuitable and Totally Unsuitable*. The neutral rating indicates that this particular factor does not influence the choice of the SI tool. This knowledge elicitation process

was then used to create a rule-based system that utilises certainty factors (CF) as a weighting criterion for the strength of each rule. A positive CF means that the tool is recommended while a negative CF indicates that the tool is not recommended. The value of the CF ranges from 1 to −1 that maps onto the aforementioned suitability scale. The end result of this rule-based recommendation system is a set of SI tools with an associated CF. Tools with the highest CF are supposed to represent those tools that are most appropriate for the specific circumstances. A total of 78 rules were extracted; the following are a sample of some of the rules:

If SI-Budget = "Low" then "PR-office" CF = −1
If Stakeholder level of interest = "High" then "Workshops" CF = 1
If Information type = "Project-related information" then "Websites" CF = 0.5
If Project phase = "Construction" then "Hotlines" CF = 1

The aforementioned rules were coded using the Java Expert System Shell (JESS). The shell was chosen due to its compatibility with knowledge representation in Protégé.

15. Case study on St. Clair Ave. West Transit Improvements Project

The St. Clair Avenue West Transit Improvements Project was used to test and validate the knowledge base. The project is currently in the detailed design phase. Stakeholder involvement in this project is being conducted as an integral part of the Environmental Assessment process. The project has the following main characteristics, from a SI perspective [4]:

- Initial SI was conducted to outline the study process and schedule; to define existing and projected problems; to identify needs and opportunities; to gather stakeholder input about transit, traffic, parking, urban design, and evaluation criteria of alternatives; and to discuss possible options for improvement of the St. Clair Avenue West transportation.
- Later SI was undertaken to present and discuss stakeholder input that was collected, to present alternative solutions, and to gather further stakeholder input about evaluation of proposed alternatives for selecting a preferred solution.
- Stakeholders including residents, owners, businesses, customers, BIAs, Ratepayers, and interest groups (such as cycling groups, environmental groups, transit rider groups, art groups, cultural groups, etc.), all showed a high degree of interest for participating in the stakeholder involvement process.
- Due to the context-sensitive nature of the project, a higher budget was allocated for the stakeholder involvement process. The budget was 20% of the total project budget.

The following public participation tools used, so far, for the project included:

- Newsletters were mailed to government agencies, community organisations, residents, businesses, BIAs and interest groups.
- Local newspapers were used to publish public notices, such as Notice of Study Commencement.
- A project Website was used to disseminate all information about stakeholder involvement in the project.
- English and special language hotlines, in Italian and Portuguese for main ethnic groups in the area, were used.
- Mail and personal surveys of residents, businesses and customers were conducted.
- Public meetings and workshops were undertaken to inform and gather stakeholder input through oral comments and comment sheets. Public meetings included open-houses, display boards and interactive boards.
- Additional meetings with any community group were conducted, outside regularly scheduled public meetings, upon request.

To test the performance of the knowledge-based system, the case of the St. Clair Ave. West Transit Improvements Project was used. It was assumed that the SI coordinator wants to select the appropriate method(s) for involving stakeholders in the pre-project planning phase by informing them about a set of design alternatives. The six decision factors had values of:

Information type = "Project design alternatives"
Phase = "Planning"
SI-Budget = "High"
Purpose = "Information"
SI Level of interest = "High"
Amount of information = "Large"

Based on these values, and utilising the 78 rules that were extracted, the prototype system made the following recommendations for SI tools:

Use Public meetings with a CF = 0.91
Use Open-house with a CF = 0.91
Use Websites with a CF = 0.77
Use Workshops with a CF = 0.63
Use PR-site office with a CF = 0.44
Use Posters with a CF = −0.22
Use TV announcements/ads with a CF = −0.47
Use Radio announcements/ads with a CF = −0.56
Use Surveys with a CF = −0.64
Use Hotlines with a CF = −0.87

Comparing the recommendations to the actual tools utilised, the following is noticed: (a) All tools having a negative CF were not used at all for this type of information

and (b) The top four tools recommended were those that were extensively used. Although most of the recommendations were governed by the need to provide two-way communication, the system's top two recommendations were using public meetings and open-house, due to the fact that there was a large available budget, stakeholder interest was high and the amount of information to be communicated was large. The value of each CF reflects the relative suitability of each SI tool which provides insight not only into tools that are suitable versus those that are not, but suggests which tools will be most effective in the given circumstances. The recommendations provided by the system can act as a 'short-list' of potential tools to the inexperienced SI coordinator. The system is not intended to replace human experience, but rather to assist in the decision making process under project-specific as well as information-specific circumstances.

16. Conclusion

Stakeholder involvement should not be overlooked when planning for a PPP project. Experience has shown that a positive involvement with stakeholders can be a decisive factor that can 'make or break' a project. Understanding of the concepts that underlie SI in infrastructure projects is an essential step towards creating a strong involvement programme that will help project proponents and stakeholders to communicate effectively. As such, this paper presented a semantic model and taxonomy for SI in infrastructure projects. The model presents a thorough representation of processes, products, actors, constraints and concerns, resources, and mechanisms. Specific concerns to PPP projects were emphasised. The semantic model has the potential to act as a core for knowledge representation in the domain of SI. One of the knowledge-intensive areas of SI involves the choice of the appropriate set of SI tools based on project characteristics and the type of information that needs to be communicated.

A prototype knowledge-based system was created based on the SI model and tested on a SI programme in Canada. Although the current prototype includes only six factors, the generic nature of the model will enable more context-specific factors to be added as appropriate. SI in infrastructure projects is a process that overlaps several domains (engineering, sociology, economics, demographic, marketing, etc.). The fragmented nature of knowledge in this domain calls for an interdisciplinary understanding of its underlying concepts. The model presented in this paper is a step towards this direction.

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